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ENTEROCLYSIS, HYPODERMOCLYSIS, AND INFUSION.

A Manual for Physicians and Students

WITH

A Chapter on the Carbonated Bath, and Some New Applications; also Therapeutic Addenda.

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BY

ROBERT COLEMAN KEMP, M. D.,
NEW YORK

Introduction BY WM. H. THOMSON, M.D., LL.D.
Physician to Roosevelt Hospital; President of the New York Academy of Medicine, etc.

Infusion, *Shock* and *Anesthesia* BY ROBERT H. M. DAWBARN, M.D.
Surgeon to the City Hospital; Professor of Surgery at the New York Polyclinic Medical School, etc.

Drawings BY THOMAS NAST, JR. *Photographs* BY DR. A. W. GARDNER.

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To the Late Henry B. Sands, M.D., this volume is affectionately dedicated by one of his former pupils.

PREFACE.

It has been our endeavor in this Manual to furnish a general guide to the topics under discussion, for the practitioner and medical student. From the great mass of material at hand, we have selected that which seemed of most practical value for our purpose. Of necessity, we have been obliged to omit much valuable work, both history, and experiments and clinical reports, on these most interesting subjects, and hence must apologize, to the authorities thus slighted, though we can conscientiously claim to have investigated all the literature that could be obtained.

Believing photography, next to clinical demonstration, to be of paramount importance in the art of teaching, we have profusely illustrated the various methods employed. To Dr. A. W. Gardner and Mr. Thomas Nast, Jr., we are indebted for our illustrations which were drawn or photographed for us by them. Our clinical material we owe to the facilities courteously offered us at the Roosevelt and Polyclinic Hospitals, and to cases of Drs. Thomson, Dawbarn and others, as well as our own.

Our experiments were conducted at the Physiological Laboratory of the College of Physicians and Surgeons (Columbia University), through the courtesy of Professors Curtis and Lee. The investigations on anesthesia and serums were carried on by Dr. Wm. H. Thomson and the author, and to Dr. Thomson we are also indebted for the "Introduction."

In our other experiments much valuable assistance was afforded us by Dr. Malcolm Goodridge, especially on Infusion, where we performed special experiments for the topic under discussion. We feel that we should credit Mr. J. T. Hoyt, the electrician of the Physiological Department of Columbia University, with special mention, since we owe to him the Hoyt's Oncometer and Tambour, which were invaluable in our work, and also his assistance in the proper manipulation of the delicate apparatus upon which the success of the experiments depend. To Dr. Cunningham we are indebted for

the excellent photograph of the experiment and for many valuable suggestions.

We have endeavored to exercise care, in properly crediting to all authors, such material as we have abstracted from their work. For the sake of accuracy, we have generally preferred to quote verbatim.

To Dr. R. H. M. Dawbarn we owe the excellent chapters on "Infusion," "Shock," and "Anesthesia." His scientific investigations on the "Temperature of Infusion in Relation to Shock," etc., are well known. We incorporated in our Manual "The Carbonated Bath" and "Therapeutic Addenda," as they contain some material which may prove of interest. It may seem to our readers that, on many occasions, we treat our subjects with extreme "minuteness of detail," such as certain "small points" in technique, etc., but on these apparently trivial factors, the success or failure of the method most frequently depend. Our Manual is the result of five years investigation, both clinical and experimental, and as such, we offer it to the profession, hoping that it may prove to be of some practical value, as well as of interest.

ROBERT COLEMAN KEMP,
444 PARK AVENUE, N. Y.

November, 1900.

INTRODUCTION.

By Wm. H. Thomson, M.D., L.L.D.

Lavage of the invisible cavities of the body in inflammatory states of their lining mucous membranes has justly taken rank among the most effective of modern remedial measures. In the case of the rectum and lower bowel, however, the greatest number of advantageous results follow from this procedure, not only by improvement in local conditions, but still more by effects obtainable through certain physiological relations upon the general circulation, as well as others secured through important nervous associations with contiguous organs. But while these benefits have long been recoguized, their attainment in practice has been hampered by the inadequacy of enemata to fulfill all the indications. The ideal procedure would be to eliminate the obstacle of the sphincter and to the outflow of the lavage, to secure both a complete washing of the intestine, and a prolonged infusion, also, when desired, upon the functions of the associated pelvic viscera. This indication, it appears to me, has been fully met by Dr. Kemp's admirable Rectal Irrigator, and I can best illustrate its uses by citing some results which I have had with it in my own private and hospital practice.

Irrigation with plain hot water, or with normal saline solution, has proved very serviceable in markedly lessening tenesmus in acute dysentery. In both simple chronic, and in membranous colitis, tenesmus is sometimes very distressing, preventing sleep and thereby seriously impairing the general constitutional state, and against this complication I have found no one measure so effective as irrigation after every movement of the bowels. The addition to the water of such an antiseptic and local anodyne as 5 to 10 drops of Oleum Menthol is also useful. In both acute, and especially chronic colitis I have often found medicinal remedies fail to complete the cure until they were supplemented by the local effects of this lavage.

Auto-infection from retention of putrid contents in the colon is not uncommonly the cause of serious cerebral symptoms. I saw a case in consultation which was diagnosed as cerebro-spinal meningitis, but as soon as the bowel was thoroughly washed out by the irrigator, the high temperature fell and the patient soon came out of coma. The same conditions are often met in the infective choleraic diarrhea of infants, and in them, intestinal lavage with normal saline solution is imperatively indicated, but against the toxic infection and for securing the beneficial effects of the saline on the blood, after it has been drained of its salts by the profuse flux.

One of the most remarkable results of intestinal lavage is its decided effects upon the secretion of the kidneys, which lead me to rank it, as one of the best and most certain of diuretics. The normal association of action between the lower bowel and the kidneys is such, that an action of the bowels can scarcely happen without simultaneously inducing a flow from the kidneys. In every case of oliguria, therefore, whether accompanied or not by albuminuria, I order repeated use of the irrigator, with the most gratifying results. In acute nephritis, it is much more efficacious than any drug that I know of, and owing to its mode of action, wholly incapable of increasing the renal derangement. It is only contra-indicated in chronic nephritis when there is abundant polyuria present, but if the quantity passed is normal, or still more if in the chronic cases it begins to diminish, intestinal lavage not only prevents, but often markedly decreases the amount of albumen.

Owing to its diuretic effects, I have found intestinal irrigation also of great assistance against toxemia in fevers, notably typhoid. If employed at the very beginning it is very noticable how often it reduces the temperature curve on the fever charts as well as favorably change the other symptoms present, doubtless owing to the increased elimination of toxins from the blood. In my hospital service I conducted for two years a series of comparative observations between typhoid fever patients treated with and without intestinal irrigation, until I became so convinced of its usefulness that I prescribe it for every patient with this fever unless signs of hemorrhage be present. These illustrations suffice to show that the uses of this simple and easily applied instrument are both numerous and important.

I might adduce many others which would be confirmatory of its application in a great number of conditions described in Dr. Kemp's book, but I doubt not that any practitioner who will give it a full trial, will soon become convinced for himself of its value.

Regarding Hypodermoclysis, I would advert chiefly to its excellent eliminative effect—a profuse diuresis resulting from a normal saline solution thus administered far in excess of the quantity so injected.

Its value in uremia, sepsis, or in any toxic condition is thus evident.

The Chapters on Infusion, Shock and Anesthesia by Dr. R. H. M. Dawbarn are well worthy of most careful study; the question of the proper temperature to employ, namely, 120° F. has been well demonstrated, as well as the proper technique of the operation. His method of Prevention of Shock by Infusion, is of great value. The chapter on Infusion is well illustrated with tracings of experiments. I would call attention to the excellent results obtained from the substitution of the carbonic acid bath for the Brand Bath in typhoid fever—illustrations of which are given in the chapter devoted to this subject; also to its diuretic, and its local applications.

In the final chapter on "Therapeutic Addenda" in addition to some formulæ of interest, and some useful instruments, there is an abstract of an article by myself and Dr. Kemp entitled "Further Experimental Researches on the Effects of Different Anesthetics on the Kidneys" which appeared in the *New York Medical Journal*, November 18, 25 and December 2, 1899. We believe this question to be of such importance that we inserted an abstract.

The purpose of the Manual we believe we have clearly indicated, and, in our judgment, it will be of considerable value to the general practitioner of medicine.

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ENTEROCLYSIS.

CHAPTER I.

INTESTINAL HYDROTHERAPY DEFINED. THE EFFECTS PRODUCED BY ENTEROCLYSIS AND ENEMA AND THEIR PHYSIOLOGICAL ACTION.

For several years past, the subject of hydrotherapy has been justly assuming an important position in our "therapeutics," and we venture to predict that the time is not far distant, when our medical schools will be compelled to give "special instruction" in this topic. We do not mean a few lectures, describing the value of water as a therapeutic agent, but a practical course in hydrotherapy by a physician of experience, with clinical demonstrations, and with the proper apparatus.

The value of the wet pack in disturbances of the circulation and in nervous conditions, can hardly be questioned, yet many of us are ignorant both of the indications and of the proper method of its appliance. In the knowledge of the correct technique of the Brand bath in typhoid fever, unfortunately many of us are lacking. Enteroclysis, or properly speaking, intestinal hydrotherapy, is included under hydrotherapy.

We would define intestinal hydrotherapy as "The employment of water in the intestinal tract for

therapeutic purposes, and administered through the anal orifice." This would include:

1. The enema.

2. Irrigation with a single tube,—true enteroclysis.

3. Irrigation with a double current tube, or with two tubes—also true enteroclysis.

4. Special methods of Türck of Chicago.

5. The application of dry heat or cold to the rectum.

Effects of Irrigations or Enemata.—The effects produced by intestinal irrigation or enemata, are due to a number of causes, which may be extremely complex, and even merge into each other. They depend also on the pathological condition for which they are employed, and on the temperature of the fluid.

We shall classify these effects, giving examples:

1. The local treatment of diseased conditions, as in catarrhal colitis.

2. The relief of congestion, or acute inflammation. Locally, as congestion of the rectum. In adjacent organs, as congestion of the prostate.

3. The relief of pain and irritability. Locally, as spasm of the sphincter. In adjacent organs, as in vesical irritability.

4. The absorption of inflammatory products, as in post-uterine adhesions.

5. To replace the loss of fluid in the body (by absorption from the intestines), as in cholera.

6. To dilute the poison of disease, as in uræmia.

7. To increase the flow of blood to a part, thus moderate heat during menstruation, if insufficient.

8. To check hemorrhage (extreme cold, or heat). Locally, as in bleeding ulcers of the rectum. In adjacent organs, as in uterine hemorrhage.

9. Effects produced reflexly through the sympathetic ganglia, as on the circulatory apparatus, on the secretions, as a tonic, stimulant, or revulsive effects. On the circulatory apparatus, as in shock. On the secretions, as in the production of sweating, bowel action, and urinary secretion in uræmia. As a tonic stimulant, as the alternate douche, in diminution of erectile power. The revulsive effect, as the production of bowel action in apoplexy, aiding to divert blood from the cerebrum. The reflex effect on a distant organ, as from enemata in jaundice.

10. The effect on the heat centers, causing stimulation or depression. The temperature can be raised in shock, by hot irrigation, or lowered in fever, by cold irrigation, or by enemata. The proximity of the irrigating fluid to the great vessels, may also directly affect the blood heat.

11. Simple cleanliness, removing undigested food products, and preventing auto-infection.

12. Antispasmodic, as by relieving spasm in colic, by the action of heat and aiding the expulsion of gas.

13. Mechanical, as in intussussception.

14. Water as a vehicle—the nutritive enema.

Physiological Action.—That these effects are due to physiological laws, is evident, and they explain the results produced. Regarding physiological action, we refer to "An American Text-Book of Physiology," edited by Dr. Wm. H. Howell; the chapters on Secretion, Circulation, Animal Heat, and the Central Nervous System.

In connection with our subject, we would note:

The series of ganglia lying on each side of the spinal cord from the base of the skull to the coccyx, and their connections.

The three great gangliated plexuses, (a) the cardiac; (b) the epigastric (solar); (c) the hypogastric and its subdivisions.

The smaller ganglia, situated in relation to the abdominal and other viscera.

The connections of all these with each other and with the cerebro-spinal system.

The distribution of their nerve fibers to the blood vessels, the coats of the intestines, and to the hollow viscera and glandular ducts.

The vasomotor, heat, and sweat centers. We should consider the close relations of the colon and rectum to the genito-urinary tract.

The peristaltic action of the large intestine is slow as compared with that of the small intestine; the conformation of the caput coli, the transverse colon, the sigmoid, and the rectum favor fecal accumulation. The absorptive power of the large intestine is of considerable magnitude, the fecal material being relieved here of its watery constituents. Septic symptoms, due to fecal absorption, in cases of intestinal paralysis are familiar to us all.

Some also believe that in jaundice (duodenal), a reflex contraction of the ducts occurs, as a result of the injections, assisted by intestinal peristalsis, which aids the escape of the bile and that by the diuresis, and hence by the elimination of toxins by the injection, the dilution of the poison plays a prominent part.

We would suggest a possible effect on the pancreatic secretion from such injections and believe this worthy of investigation.

Dr. Simon Baruch, our eminent authority on hydrotherapy, demonstrates that the "action of water on the human economy, varies markedly with the

temperature employed and the length of its application."

This is especially true of enteroclysis; on account of the proximity to the great plexuses and the genito-urinary system, the temperature of the fluid employed, is of paramount importance. Ignorance in this regard, may cause positive injury to the patient.

The question of the proper temperature is the "key-note" of this entire subject.

The following chapter will therefore be devoted to, "Physiological Experiments with Enteroclyses at Various Temperatures." There will be experiments relating to renal secretion, intestinal absorption, hypodermoclysis, and infusion.

CHAPTER II.

EXPERIMENTS WITH ENTEROCLYSIS, HYPODERMOCLYSIS, AND INFUSION.

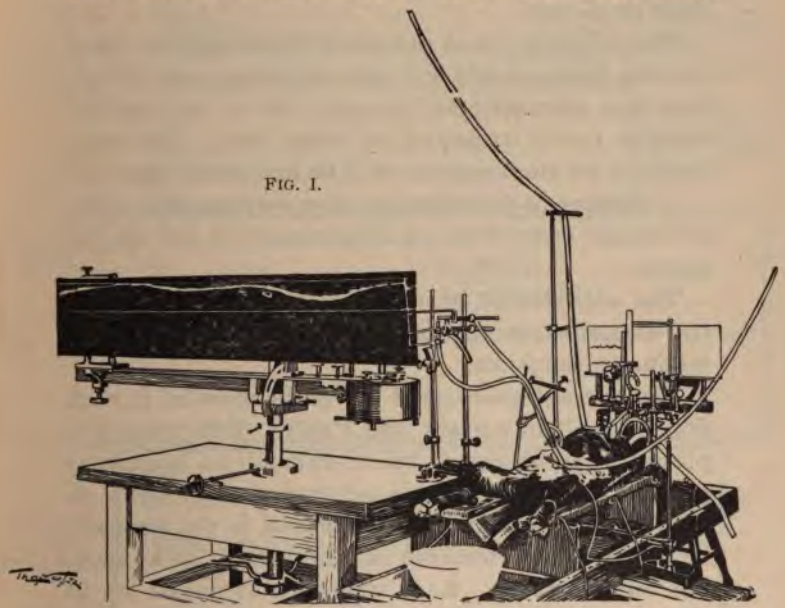
We will now give a resumé of the experiments. Our first set, was on the effects of enteroclysis, or enemata, administered at various temperatures, on "pulse tension, temperature, renal secretion, and intestinal absorption." They were conducted in the physiological laboratory of the College of Physicians and Surgeons (Columbia University), and to Professors Curtis and Lee, our thanks are due for the facilities there afforded us. For a better understanding of the methods employed, we would call attention to Fig. 1.

This depicts our experiment with anæsthetics, which differs from the experiments now to be described, in that the kidney tracings (represented by the irregular, broad white lines on the smoked paper), are here demonstrated, and that the tube attaching the oncometer (kidney box) to the drum (tambour) with its pen, are also shown. At the head of the animal, is the kymograph, the small black tracings being secured from the carotid artery and giving the blood pressure. In some cases the femoral artery was employed.

The tracheotomy tube attachment, is the long white tube at the head of the animal, passing downward and to the right and extending over the edge of the table. Through this, the anesthetic was administered when necessary, or artificial respiration, if indicated. At the right, is a small vertical stand-

ard with an arm (lever) passing to the left, toward the animal, and at the end of this is a spatula. The left ureter was catheterized, and the drops of urine passing through a tube, fall upon the spatula, and are caught in a vessel beneath. The lever is supported by a sensitive tambour, and the impact of every drop

FIG. I.



Experiment.

on the end of the lever, is transmitted to another tambour, through a tube containing a column of air. On the second tambour is a pen. Each drop of urine is registered on the smoked paper, in the form of an inverted V.

The opposite ureter was catheterized, and the urine collected and measured. The mercurial manometer was connected with the artery, to secure the pulse

tracings, and the impulse of the heart was transmitted by this column to a small float, on which is a pen supported by a rod. These impulses were written in ink on a paper, which moved along on the revolving drum of the kymograph.

As animals of some size were preferable, dogs were employed.

The irrigating fluid consisted of normal salt solution (a dram of salt to a pint of water), and irrigation was administered through one of our double-current rectal irrigators, of infant size. The technique of its employment, will be described later.

A number of experiments were performed, in order to exclude errors from an idiosyncracy in any special animal.

The attachment of the ureter was only made in the experiments relating to renal secretion and intestinal absorption.

The average quantity of morphine injected in each dog, was about a grain and a half. Ether was employed when necessary, but in as small an amount as possible. The normal blood-pressure was noted in each case. This differed somewhat in the animals. Enteroclysis was then begun, and carried on at varying temperatures. Each irrigation averaged ten or fifteen minutes. The following paragraphs give the average results of all experiments:

Effect on Pulse Tension.

Temperatures, 100°–101°-102°F. Very slight pressure; increase; in some none is detected.

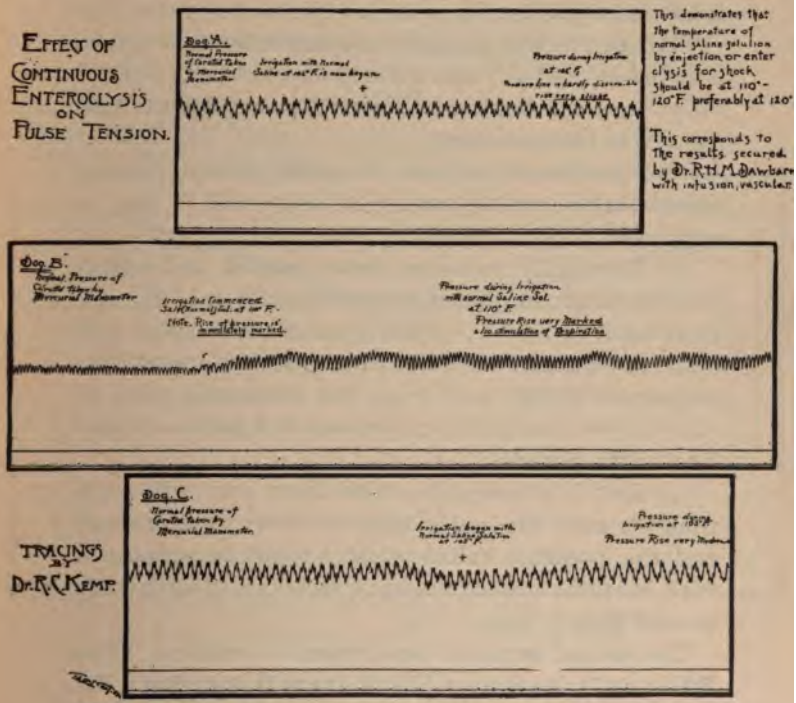
Temperature, 103°-105° F. Pressure increases slightly.

Temperatures, 105°–110°F. Pressure increasing progressively with the temperature.

Temperature, 110° F. Marked pressure increase; respiratory curve changes; respiration rapid.

Temperature, 110°–120° F. Very marked rise of pressure, progressively increasing; pulse very full;

FIG. II.



Effect of Enteroclysis, at various temperatures, on Pulse Tension. (102°—105°—110° F. were employed.)

heart action strong. This degree of heat most markedly increases tension and stimulates the heart (See Fig. 2).

Temperatures, 90°–60° to iced water, (this averages 36°–37° F). Marked increase of pressure, becoming greater as the cold increases.

Note.—After twenty to twenty-five minutes' irrigation with the lower temperatures, the heart action becomes weaker, and the pressure falls.

Deductions.—(1) Irrigate at 100°, 101°, 102° F.; or even to 103°–104° F., if increase of pulse tension is to be avoided.

Though physiologically a slight pressure increase is noted at 100° F., and greater at 102°–104°; clinically, none can be detected after the employment of the above temperatures.

(2) If moderate increase of pulse tension is not objectionable, a temperature of 105°–108° F. can be employed.

(3) To rapidly increase pulse tension and stimulate the heart, employ a temperature of 110° F., and increase it to 120° F. This is excellent in shock and allied conditions; before, or during severe operations, to prevent shock, and from the commencement of chloroform anæsthesia, to prevent the sudden dilatation of the vessels.

(4) Cold is a temporary stimulant, and will for a time increase the pulse tension; later it depresses, and the pressure falls. Cold should be employed with caution. More patients have an idiosyncrasy to cold than to heat.

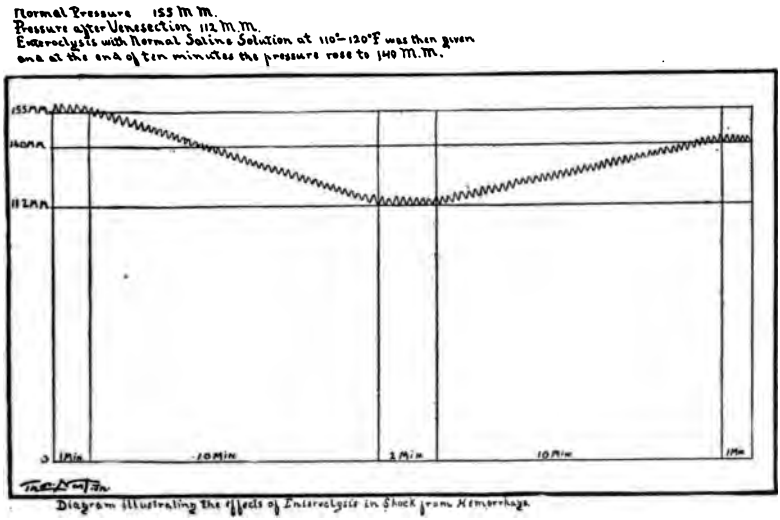
The second series of experiments is entitled, "The Effect of Irrigation on Shock from Hemorrhage."

We noted the respective pulse tension in each animal, and then withdrew blood from the femoral, watching the effect on the pulse tension and heart. The blood was received in a vessel and afterward measured. We report one experiment. Weight of dog, 20 pounds.

The blood pressure was 155 mm. We removed 50 cubic centimeters at a time, until 509 cubic

centimeters in all had been removed; the pressure fell rapidly to 112 mm. Enteroclysis was at once begun with normal saline at 110° F. and rapidly increased to 120° F. Immediate rise of blood pressure followed, and in ten minutes reached 140 mm. and remained steady at that point, the heart was acting with fair force (see Fig. 3).

FIG. III.



Effect of Enterocysis in Shock from Hemorrhage.

To tabulate: Normal blood pressure, 155 mm.; blood pressure after hemorrhage, 112 mm.; blood pressure after saline irrigation (at 110°–120°) rises to 140 mm. in ten minutes.

Deduction—Irrigate with normal saline solution, 110°–120° F., in "Shock from Hemorrhage," preferably at 120° F.

Our third series is entitled "The Effect of Irrigation on Temperature."

The animals were prepared, as usual.

In some, a clinical thermometer was inserted in the left common iliac artery, the tip of the thermometer lying flush with the wall of the abdominal aorta, but not projecting into it. The thermometer was tied in firmly. In others, thermometers were inserted into the left common carotid, the tip lying flush with the wall of the aorta and there tied. All the animals were dissected later, to demonstrate that no clotting occurred, which could interfere with the experiments. In some, the manometer with the kymograph was attached.

Incisions were made in the axillæ, and thermometers were inserted, to secure the normal temperature and the changes that might occur. All the animals were uncovered, and in a room of about 72° F.

Before irrigation: Axillary temperature averages, 99°–99.5° F.

Temperature of the aortic blood averages 102.5°–103.5° F.

Normal blood-pressure varied from 125 mm. to 150 mm.

A period of about fifteen minutes was allowed to elapse before irrigation that the anesthetic might have no influence on the temperature.

Irrigation for twenty minutes at 110° F., increasing to 120°.

There was a gradual rise of temperature; axillary temperature increased 1° F.; temperature of aortic blood increased 0.5° to 0.8° F. Pulse tension markedly increased.

Hot irrigation was then suddenly changed to cold —iced water (averaging 36°–37° F.),—and this was continued for twenty minutes with the following result: Axillary temperature fell 2° F.; blood tem-

perature fell 1° F. Pulse tension at first continued high, later fell, and heart became rapid and feeble.

Temperatures of the irrigating fluid at 100°–105° F., had no influence on the temperature in twenty minutes.

Temperatures of 105°–110° F. caused slight increase of temperature in twenty minutes.

Temperatures of 90°–60° F. caused no appreciable change in temperature.

Below 60° F. there was loss of temperature in twenty minutes, but not marked, until the extreme degrees of cold were reached. There were idiosyncrasies in the animals. These results are the average in about eighty per cent. of the experiments.

N. B.—It has been noted that dogs when covered and etherized, suffer an increase in temperature when in a room of about a temperature of 72° F.

The absence of sweat glands, except rudimentary ones in the paws, readily accounts for the phenomena exhibited by these animals during the heat of summer. When the animal is covered, there is no heat dissipation, and as ether is a stimulant, the increase of body temperature is understood. The animals were purposely left uncovered, and the axillary and blood temperatures carefully noted within three minutes after the thermometers were tied into the vessels. A period of ten to fifteen minutes was allowed to elapse before irrigation was begun. There was no change in the temperature. This corresponds to the result found by others, that the temperature of the uncovered animal in a room at 72° F. is not increased by ether.

Irrigation was then begun at 110° F. and increased to 120 F., with the resulting rise of temperature, which was thus unquestionably due to the hot saline.

Extreme cold, when prolonged, always reduced the temperature, moderate cold causing some reduction. It was at first stimulating, but later depressing.

Deductions—1. Hot irrigation, 110°–120° F. when prolonged, increases the temperature of the body and blood. The increase of blood temperature is possibly partly due to the contiguity of the solution to the great vessels, as well as to the effect on the heat centers. The heated blood would be of value to stimulate the heart, and hence the further advantage of irrigation at a high temperature in shock.

In severe febrile conditions, it might not be advisable therefore to irrigate with fluid at a high temperature. It depends, however, on the etiology of the fever, as will be determined later.

2. Cold irrigation reduces temperature and at first stimulates, but later depresses.

3. Clinically, enteroclysis at high temperature (110°–120° F.), has proved excellent in shock and allied conditions.

Cold Irrigation.—Dr. Chapin employs cold enemata in the diarrheas of children, to aid in the reduction of temperature. It has been used in dysentery with good results. It might be used with caution in sthenic cases, as of heat stroke, to reduce temperature. Friction of the limbs during its application, might be advisable. We should not employ at first a temperature below 60°–70° F. It would probably be safer to use it only two or three minutes.

We have seen benefit in jaundice (duodenal) from irrigation briefly employed (two quarts), or from the alternate hot and cold douche (two quarts each), for chronic constipation, also from cold enemata.

A glass Y-attachment, as suggested by Dr. John

Minor, is excellent for this purpose. The above observations apply to high irrigation.

Cold rectal irrigations are much safer, and we have seen iced water so applied for thirty minutes, in a congestive condition of the rectum, with great benefit. Some have an idiosyncracy to cold, and it should be employed cautiously.

Hare reports a rise of 4°–5° F. in dogs, after twenty minutes' irrigation, with a temperature 115° F.; also a marked fall of temperature, practically shock, after its use for twenty to thirty minutes. Whether or not the animal was covered, also the temperature of the room, are factors that should be considered. Our experiments agree as regards cold, but differ in degree, as regarding the heat.

Our fourth series was, "On the Effect of Irrigation at Different Temperatures, on the Secretion of the Kidneys, and the Length of Time it Requires for Intestinal Absorption to Occur"; also "On the Specific Effect of Small Quantities of Normal Saline Solution in Promoting Renal Secretion." There are certain laws of physiology which regulate the renal functions. To quote: "

1. Other conditions remaining the same, the secretion of the kidneys varies with the quantity of blood flowing through them—the greater the quantity of blood the greater the secretion.

2. The blood flow through the kidneys and therefore their secretory activity, may be affected by conditions influencing general arterial pressure. The condition of the renal circulation itself and also its relative condition as regards the general circulation, have an important bearing on the subject." See "An American Text-Book on Physiology," edited by Dr. Wm. H. Howell, in the chapter on "Secretion.'

The usual method was employed, and in addition, the ureters were catheritized as described.

That enteroclysis and enemata are of value in any condition affecting the kidneys, is well known to us all, and in this connection we would call attention to the clinical experiments carried out by Dr. H. E. Forrest, and reported in the *New York Medical Record*, September 19, 1891. He notes the value of large injections of very hot water, stating that the diuretic effect is marked, and results both from absorption of the fluid, and also from the heat. This last we would have our readers note carefully. Forrest advocates washing the intestine, as preliminary to an injection that is to be retained. He cites cases. Still further back, Dr. Prince invented his obturator,—year 1881 and reported the same,—to retain injections for purposes of absorption, and cites its use in renal conditions, shock and sepsis. This will be demonstrated later.

Irrigation with normal saline solutions at 100°–120° F.

Temperatures, 110°–120° F. Increase of renal secretion in ten minutes, very marked in twenty minutes. Marked increase of pulse tension. Note two cycles of increase of secretion.

Temperatures, 100°–103° F. No increase in renal secretion noted until twenty minutes, then is considerable. Slight increase in tension. Note one cycle of increased secretion.

Temperatures, 105–110° F. At the higher temperatures a slight increase of secretion in ten minutes; at the lower temperatures no increase until twenty minutes. At all the temperatures, 105–110°, considerable increase in twenty minutes.

Five cubic centimeters of a [illegible] ion of

ferrocyanide of potassium, were added to about a quart of the irrigating fluid, and the return fluid was caught and employed again several times. In other animals, repeated irrigations in each animal, with a five per cent solution of potassium ferrocyanide, five cubic centimeters in each quart of the saline, were employed. The urine as it came from the ureter, was tested every minute with chloride of iron. In twenty minutes, the urine gave the Prussian blue reaction. This was the average length of time, whether the temperature of the irrigating fluid was 100° or 120° F., or at the intermediate temperatures. Absorption occurred in about twenty minutes, as an average.

The Specific Effect of Normal Salt Solution on Renal Secretion.—Thus a small enema of normal saline solution, or an enteroclysis at about 99°–100° F. at the end of twenty minutes, would cause increased diuresis, as demonstrated by the greater number of drops of urine registered on the kymograph at this period, and that too, synchronously with the appearance of the Prussian blue reaction in the urine by the chloride of iron test, and due to the potassium ferrocyanide contained in the salt solution. No detectable rise of pressure occurred in the manometric tracings, so the increased secretion was evidently due to the action of the saline solution on the kidney cells, since it corresponded absolutely to the time required for excretion by the kidneys of the saline absorbed from the intestines.

We have noted clinically, as have others, the enormous increase of renal secretion, following even very small enemata, of normal saline solution. Thus in response to nine ounces of normal saline solution, given at half-hour intervals in divided

doses,—three ounces at each injection,—there resulted forty ounces of urine, within five hours from the first injection. Only ten ounces of bloody urine had been voided in the previous ten, or eleven hours. The urine after the injections, also was much less bloody in appearance. This case is reported, in "The Transactions of the Association of American Physicians," vol. xiii, 1898, page 402, in a case of chronic infective endocarditis, a patient of Dr. William H. Thomson. We have frequently observed this enormous response to small enemata of normal saline solution,—often three to five times the amount of urine being secreted, as compared with the quality of saline injected. Our experience seems to show, that the smaller quantities frequently repeated, give better results than a few single large injections.

Deductions—In ten minutes, irrigation at the higher temperatures, 110–120° F., stimulates the kidneys to secretion, by the heat, and by the stimulating effect on the circulation, also by the heated blood flowing through the organs.

NOTE.—The increase in secretion at the end of ten minutes, corresponds to the maximum height of pressure obtained by enteroclysis at 120° F—in "Shock from Hemorrhage," and to the commencement of temperature increase, in the "Experiments on Temperature."

In twenty minutes, irrigation at 100–120° F. causes excretion from the kidneys through absorption from the intestines, as shown by the potassium ferrocyanide experiments.

If the temperature or pulse tension is not too high, irrigate at 110°–120° F. This acts by the stimulating

effect on the circulation, also by the heat, and by absorption of the fluid from the intestines.

If it is desired to increase renal secretion without increasing pulse tension or temperature, irrigate at 100°–104°F., and at 105°–108°, if moderate increase is not objectionable.

Intestinal absorption from the large intestine, occurs in twenty minutes. This has an important bearing on self-infection. Hence the value of irrigation in diarrheas.

Dr. L. Bolton Bangs has administered enemata of iodide of potassium, and secured reaction in the urine in twenty minutes.

Clinically—Hot saline irrigation is an excellent remedy in acute uræmic suppression, or in cases of renal insufficiency. It also aids elimination of toxins through the kidneys, in typhoid fever, septic endocarditis and in septic conditions.

Dr. Egbert Grandin has had excellent results from this procedure. Dr. William H. Thomson has employed it with success, when other means have failed. They report profuse sweating and bowel action accompanying the renal secretion. Dr. Thomson has employed saline irrigation at 103°–108° F. with gratifying results, in an obstinate case of renal insufficiency.

Renal disease, with polyuria as a symptom, would seem to contraindicate it, or that it should be cautiously used, and for short periods. This is in reference to a case of enlarged prostate, in which prolonged irrigation was employed. It aggravated the polyuria, and had to be stopped.

It will be noted, that no reference has been made to the effect of cold irrigation on renal secretion.

Some advocate cold enemata in renal suppression, but we consider them dangerous.

Enemata of cold water at different temperatures will be absorbed from the intestines, and as with hot enteroclysis, with potassium ferrocyanide in the solution, the usual reaction will occur in about twenty minutes with chloride of iron. Cold irrigation will, for a short time, stimulate the circulation and increase secretion, but in about twenty minutes, the pulse tension will fall, and the animal will go into shock, and renal secretion will cease. We will thus have renal suppression plus shock, and be worse off than before.

Cold irrigation we believe to be contraindicated in renal disease,—also cold enemata.

We must remember that results from physiological experiments on healthy animals, are modified by existing clinical conditions. In the deductions as to temperature, for example, irrigation at 110–120° F. was recommended, when the pulse tension or temperature were not high. The nature of the case, the age of the patient, and other conditions are to be considered. We have seen excellent results in acute uremic suppression with considerable pulse tension and a temperature of 102° F., from a twenty-minute enteroclysis at 110°–115° F., with profuse diuresis, sweating and bowel action following, and a fall of pulse tension. Dr. Simon Baruch has had a similar experience.

If the vessels are atheromatous, a great degree of heat might be undesirable, but nitroglycerin 1/100 gr. hypodermically previously to the enteroclysis, would minimize such danger.

In order to compare the time required for renal secretion to appear, when due to intestinal irrigation,

with that following hypodermoclysis and infusion, we conducted two more series of experiments.

Our fifth series was on "Hypodermoclysis."

The usual method was employed, the ureters being catheterized and the record of urine obtained, as in the preceding experiment.

Five cubic centimeters of a five per cent ferrocyanide of potassium solution, were added to about three ounces of a normal salt solution at 104° F. This was injected with a large syringe into the tissue of the right groin. The urine was tested every fifteen seconds with chloride of iron. In three and a half minutes, the Prussian blue reaction was noted, which became marked in four minutes. Renal secretion slightly increased. This was demonstrated by the increase in the number of drops registered on the one side, on the revolving side of the kymograph, and counted on the other, coincident with the appearance of the Prussian blue reaction.

The Specific Action of Normal Saline Solution in Promoting Renal Secretion.

We again observed the specific action of normal saline solution, even in small quantities, in promoting renal secretion. Thus when ℥ss of normal saline solution by injected subcutaneously, in three an a half to four minutes increased renal secretion began, again coincident with the Prussian blue reaction, and without any appreciable rise in the pulse tension, as demonstrated by the manometer tracings.

Only when a considerable quantity was injected, could any change be observed in the tracings of the circulation.

Renal Congestion is Lessened by the Injection of Normal Saline Solution (Hypodermoclysis).

Renal congestion was produced artificially in rab-

bits, by enormous injections of antistreptococcus serum and of normal horse serum. Normal kidneys were first examined microscopically, and then congestion of the kidneys in other animals was produced, as above, and the pathological condition noted.

Experimentally, we found that if a serum injection is followed later by a normal saline hypodermoclysis, renal congestion is much lessened.

The same doses of these serums, if followed by saline hypodermoclysis, caused markedly less congestion than when injected alone.

Deductions.—This method would be of value: (1), In shock. (2), In shock from hemorrhage. (3), In cholera, cholera infantum, severe diarrheas, etc., to replace the loss of fluid and dilute the poison. (4), In acute uræmic suppression, renal insufficiency, etc., to start up secretion and dilute the poison; in septic conditions, to dilute the poison and eliminate it through the kidneys, also to reduce the renal congestion; also in any dropsical condition due to oliguria, as in pulmonary, edema, or in pleurisy with effusion. (5), In septic conditions to dilute the poison and eliminate the toxins through the kidneys, as in diphtheria. (6), In preparation for anæsthesia, to replace loss of blood, and also to lessen danger of post-operative uræmia.

The Rapidity of Absorption is Modified by Existing Clinical Conditions:

Though hypodermoclysis under normal conditions is, in rapidity of entering the circulation, next to infusion itself, yet under certain other clinical conditions, the absorption is much delayed, and for practical use, it is actually the least rapid in its action of the three methods.

Thus, in uræmic conditions, with a feeble circulation, or in shock, or in any condition of such a character, the absorption of the lymphatics will be nearly at a standstill; even a small hypodermoclysis, will take a considerable length of time to be absorbed. A subcutaneous injection, besides, has a certain degree of tension to overcome, (caused by the pressure of the fluid itself), and also does not possess the advantage of stimulating by its heat, since a high degree of heat might be harmful in circumscribed cellular tissue under high tension, especially with the blood supply already enfeebled.

This will be treated of at length, under "Hypodermoclysis," in order to illustrate that the results of physiological investigation when applied clinically, are modified by the physical condition of the patient.

Our sixth series of experiments was on "Infusion."

The same method of operation as in hypodermoclysis, was carried out. One cubic centimeter of a five per cent potassium-ferrocyanide solution in three drams of normal saline solution at 110° to 120° F. was infused slowly into the right femoral vein. The urine was tested every fifteen seconds. In one and a half to two minutes the Prussian blue reaction in the urine with chloride of iron appeared. Renal secretion was slightly increased.

[Note.—When small quantities are infused, there is no increase in pulse tension; the manometer tracings rise only with larger quantities].

The Specific Effect on Renal Secretion Produced by Small Quantities of Normal Saline Solution.

Thus Foster has demonstrated an immediate increase in the renal secretion, following an infusion

with saline solution, even when an infusion of so small a quantity was given, that no change in the general blood pressure occurred, and when in addition, there was a complete severance of all the renal nerves; evidently a specific effect on the secreting cells of the kidney.

By infusion of small quantities of normal saline solution, we secured diuresis in one and a half to two minutes, by the method above described. There was no rise in the manometric tracings, the quantity infused being too small to influence the circulation.

We also repeated the experiments of Dr. R. H. M. Dawbarn, with various temperatures, with infusion, again demonstrating, as he did in 1891, that a temperature of 120° F. best stimulates the heart. In the chapter on "Infusion," written by him, a full description of his work will be given.

He was the first to suggest and likewise to employ normal saline solution at 120° F., during, or after, operation to prevent shock. In the course of his experiments, he found infusion of sterile water (plain) killed the animals, by destroying the red cells.

Comparison.—Infusion: Renal secretion occurs in a minute and a half to two minutes; some claim within a minute.

Hypodermoclysis: Renal secretion occurs in three minutes and a half to four minutes.

Enteroclysis: Renal secretion occurs in twenty minutes.

On Infusion: Deductions from Dawbarn's Experiments.—1. High temperature of the saline solution, 120° F. is the best stimulant; (a) in shock; (b) in shock from hemorrhage; (c) before or during severe operation, to prevent shock, or to prevent dilatation of vessels during chloroform anæsthesia.

On infusion: Deductions from Kemp's Experiments.—1. Useful in cases of acute uræmia to dilute the poison and cause renal secretion; also in cholera, severe diarrhœas, sepsis, etc. It should be employed as a stimulant, to dilute the poison and aid elimination through its diuretic action on the kidneys, or to replace the loss of fluid from the body, as the case may require.

This method has been reported as successful in some cases, a definite amount of blood being withdrawn by venesection, and this replaced by saline solution. It was first performed abroad.

In closing, we wish to express our indebtedness to Mr. J. T. Hoyt, electrician at the laboratory, to whose skill we feel we owe the success of our experiments. Special tambours, etc., were made by him for us, as well as an oncometer of improved form.

We are aware that experiments have been performed in regard to intestinal absorption, and the effect of enteroclysis on the temperature of the body (Hare); but of the method of insertion of thermometers into the great vessels, the experiments with continuous enteroclysis in shock from hemorrhage, and the effects on renal secretion produced by irrigation at various degrees of temperature, we have been unable to find any previous record.

We trust, however, that these few experiments may arouse sufficient interest, to induce others to enter into a more thorough investigation.

CHAPTER III.

THE ENEMA.

We have already classified the methods employed in intestinal hydrotherapy, and in this chapter we shall treat of the first subdivision—the enema.

This is unquestionably the oldest method, fulfills many indications, is simple, and in some cases may be considered ideal.

An enema may be (*a*) high, or (*b*) low.

(*a*) *The High Enema* is administered through a colon-tube, or long catheter, attached preferably to a fountain syringe, or a vessel arranged on a similar principle. The bag should hang about two or three feet above the patient. The fluid should be allowed to flow in slowly, so as not to excite intestinal spasm, and thus resistance to its flow. The colon tube should be well lubricated, preferably with sweet oil or vaseline, and inserted gently for twelve to eighteen inches. After the tip has passed the sphincter the passage of the tube is often assisted by allowing the fluid to run through it, so as to give it greater stiffness, as it is pushed up the bowel.

It is thus less likely to curve on itself. An extra opening can be made in the catheter, a short distance below the eye and on the opposite side, so as not to weaken it. The rough edges can be smoothed by holding it over a flame, and wiping it quickly when softened, with a wet cloth or moistened finger. This makes a velvet eye.

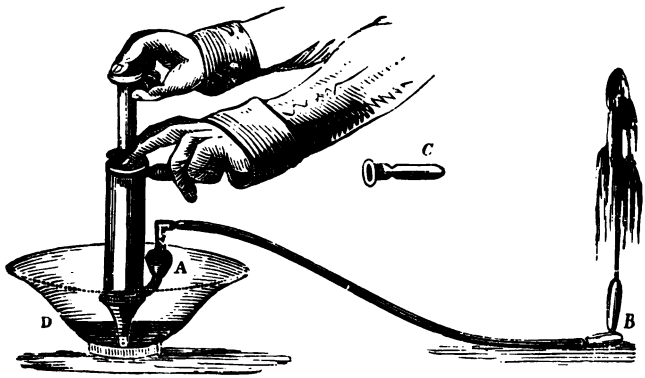
In infants a small catheter, No. 16 or No. 18 French, can be used. The water employed for an

enema, both hot and cold, should preferably be sterile (*boiled forty-five minutes to an hour*). Emergencies may arise, or conditions be such, that this is impossible.

The Davidson syringe is not as desirable as the fountain syringe, since the flow is apt to be intermittent and often forcible, and so excite spasm of the intestines.

Position of the Patient. Dorsal positton with hips

FIG. IV.



Enema Pump.

elevated, is as a rule the best. Elevation of the foot of the bed by means of blocks, is also of service. The knee-elbow position is at times employed, to secure a very high injection.

Uses of the High Enema:

First: To secure action of the bowels. It is employed especially for fecal accumulation, or impaction, also to relieve tympanites, etc. The average quantity to inject is one to one and a half quarts at a temperature of 101–103° F.; soap (brown or castile) should be used in the water, making fairly thick

suds. Half a dram to a dram of spirits of turpentine, may be added if typanites. Two drams to half an ounce, or or an ounce of olive oil, or glycerin can be added to the enema if necessary.

Note.—A high enema can be given with a short rectal tip, in the knee-elbow posture, if a long lube cannot be procured.

In infants of six months, a half a pint to a pint; at two years of age up, to one and a half pints of water. A dram to two drams of sweet oil may be added.

Fig IV. shows an old-fashioned enema pump.

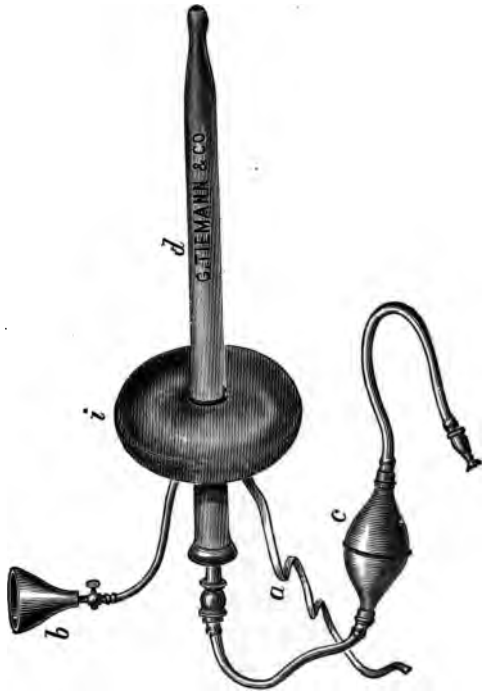
The habit of relying on the enema, either for adults or infants, is pernicious, and the frequent prescription for its use, is poor therapeutics. Ultimately, dilatation of the intestine and loss of muscular tone, may result from its too frequent employment, practically a paralysis of the gut.

We deem it proper at this point, to mention Küssmaul's method of oil irrigation, for the treatment of constipation. He employs about a pint of olive oil, given by enema at bedtime. He injects it slowly through a long tube, the patient lying down first on the left side, then rotating gradually to the dorsal position, then to the right side, with gentle massage accompanying it. The enema is to be retained if possible. This method of injection, by postural treatment, corresponds to our "Method by Rotation," later described, and which was reported in the *New York Medical Journal*, March 13, 1897.

Second: For stimulation as in shock, or in shock from hemorrhage, or in heart failure during anæsthesia—as from chloroform, etc., a high hot enema, a pint to a quart or even two or three quarts at a time of normal salt solution (one dram of salt to one pint of water) may be given. The temperature of the

fluid should be 115–120° F., preferably the latter, to obtain the best results. The enema can be repeated in one to three hours, if indicated. It should be injected slowly through a long tube, with the hips elevated, or better, with the foot of the bed well raised.

FIG. V.



Prince's Rectal Obdurator.

On withdrawing the tube, a pad should be placed over the anal orifice firmly, and the buttocks held together for ten to even thirty minutes if necessary. If the larger quantities cannot be retained, then employ two to four ounces, repeating it frequently every

one half to one or two hours, even these are of service.

Note.—The employment of water enemata for shock, uræmia and sepsis, which is not a recent procedure; Prince's Rectal Obturator (Fig. V.) is found in Tiemann's catalogue, was devised by Dr. Prince some twenty years ago, to retain enemata for such conditions. A collapsed soft rubber bag is passed into the rectum. A Wales' rectal bougie, fitting snugly, is previously passed through its center, and pushed into the bowel, with the bag collapsed. The bag is then inflated with water, or air, through a tube. This acts as a plug and prevents the escape of fluid. Water is injected through the bougie high up into the bowel, and the bougie clamped. After the absorption of the fluid, the bag is emptied and removed, together with the bougie.

3. In uræmia, insufficiency, or suppression of urine, also in septic conditions, as in septicemia, cholera, diphtheria, etc., to replace the loss of fluid from the body. It stimulates the kidneys and dilutes the poison of the disease. The enema can be repeated in an hour or so, or sooner, if retained. It can also be employed in post-operative thirst, resulting from hemorrhage. In cholera, it aids in replacing the loss of fluid, also in severe gastro-enteritis and in similar conditions, injected at 105°–110° F., to suit the case. Hypodermoclysis may be used in addition. In uræmia several gallons are often injected preferably at 115°–120° F., in divided quantities, within a few hours.

4. In jaundice (duodenal). Inject cold water 60°–90° F. slowly, one to three quarts at a time, depending on the case. Some do better with hot water, 102°–105° F. to 110°, 115°, 120° F. Two quarts

daily are generally sufficient. This method is used as an adjunct to other treatment.

5. Enemata,—to be retained a moment or two and then passed,—practically an "irrigation." These can be employed in catarrhal colitis, dysentery, cholera, gastro-enteritis, typhoid, etc. In such cases, an average of one to two quarts. injected slowly, is sufficient, at 101°–104° F. is the average, but even to 110°–120° F., if the patient is in collapse. In the cases where medicated enemata are employed, some give first a simple enema of water, or normal salt solution, to empty the bowel. In dysentery, weak ipecac (pulv.) solutions by high enema may be given, when it is subacute. Weak nitrate of silver solutions are also excellent, followed by a saline enema, if the action of silver is thought to be too severe. Quinine solutions 1 : 2000–1 : 1000 in amœbic cases, are excellent. Cool injections are occasionally employed. (See paragraph 7 below).

[Note.—Various solutions are employed. These will be mentioned later in "Double-Current Irrigation." (See pages 73-75 for the formulæ employed).

6. In case of hemorrhage (intestinal), water, very hot, 110°–120° F., or cold, 60–90° F., or even iced water, one to two quarts, may be injected slowly. If shock, then employ heat at 110–120 F. Fresh beef blood has proved of value in hemorrhage from typhoid ulcers; a high injection may be given of one to two quarts. This is said to aid in the immediate formation of a clot and so check the blood flow. Dr. T. T. Gaunt, of this city, has employed it with success, and we wish to express our indebtedness to him, for our information on the subject.

N.B.—All the above injections are given once or twice daily, accordihg to indications.

7. To reduce temperature. High injections of cold water, one to two quarts in adults, as in dysentery, insolation, etc., care being taken to avoid shock. Dr. Chapin, of New York, employs such injections to reduce temperature, in cases of gastro-enteritis, and states that the water is warm when evacuated. In children, from one-half pint to a pint or a quart can be used, care being taken to avoid shock. The temperature of the water should be 60°, 70°, 80°, 90° F. Some employ colder solutions. Many deem it safer to employ a a temperature of 95°–100° F. It will reduce temperature, and certainly the danger of depression is much eliminated.

N.B.—All water employed for these solutions should be sterile. Boiling it for forty-five minutes is sufficient. The temperature can be regulated by the addition of cold boiled water.

8. Nutritive high enema. Grandin first washes out the large intestines with normal saline, with a colon tube. There is then less irritation of the bowel, and the enema is absorbed much better. A short time after this, the nutritive enema is injected, also with the colon tube. Further particulars will be given, under the nutritive enema (low).

9. Mechanical, as in intussusception.

Position of Patient—Hips elevated; shoulders depressed. Some recommend Trendelenberg's position. Emmet Holt, in cases of infants or young children, places the patient in the dorsal position, with the thighs flexed, and from time to time during the injection inverts the patient, gently manipulating the tumor through the abdominal wall.

The Long Colon Tube is used for adults; a small catheter, about No. 18, is employed for infants.

Hydrostatic pressure should be used.

The height of the bag of the fountain syringe should be four to five feet above the patient, giving a pressure of not over three pounds. Occasionally it may be necessary to elevate it more, to increase the pressure, even to six or eight feet, but this is rarely advisable.

Solutions.—Either water or normal salt solution. Holt also advises milk and water or thin gruel. They are all less irritating than plain water. Normal salt solution is excellent.

Temperature of the fluid: 100–105° F. for the relaxing effect.

Quantity of the fluid.—This is variable, depending on the position of the intussusception. It depends mostly on the judgment of the physician. *The best guide to the amount, is the tension of the abdominal walls.* The buttocks are held tightly together during the injection to prevent escape of the fluid. In the event of too much tension these are relaxed, and, if necessary, in addition to this, more fluid is allowed to escape through the injecting tube.

As a further guide, we can remember that the colon of an infant six months old will hold about a pint *without distension*, and at the age of 2 years two pints, or possibly three pints. The adult colon holds considerably more than a gallon (Weir says nine pints or little over) without distension. One would employ one to two quarts on infants, and two to four to six quarts on adults, depending on symptoms of tension, etc.

An anesthetic should be administered.

Holt prefers the injection of air.

Pressure should be kept up for from ten to twenty minutes or even half an hour. If the injection fails to reduce the intussusception then stop. It can be

attempted again within two hours, and if failure, then resort to laparotomy. Our own view is to resort to operative interference after one failure of the injection.

N.B.—Pynchon, in the *Chicago Medical Recorder*, 1896, December number, reports a case in a girl fourteen years, in which two and a half gallons of water were used—a gallon gushing from the mouth as the intussussception was reduced. He places patient head downward. He advocated large quantities of water—two or two and a half gallons, and extreme height of douche bag—eight to ten feet. We should consider the procedure an extreme one and not to be advocated.

10. To relax spasm, as a high enema in intestinal colic, or to aid the passage of a renal calculus, especially if lying in the ureter. Employ a hot enema, 105-108° F.

The Low Enema:

(*b*). The low enema is given in the rectum best from a fountain syringe, with short rectal tip, well lubricated. The Davidson syringe can be employed. If the case is especially sensitive a catheter may be attached to syringe tip and inserted three or four inches.

Position, generally dorsal, though the sitting position is employed at times. The position should always be dorsal, or Sims', with elevation of hips, if the fluid is to be retained.

Note.—The sphincter and nates should be protected with oil or vaseline where high temperatures are employed.

Indications. 1. To secure action of the bowels, preferably the dorsal in chiefly the rectum, as in fecal accumulation, impaction, etc. Small enemata and

repeated are of value; overdistension is to be avoided. Enemata of sweet oil, especially in children, are of benefit. Avoid habitual enemata for constipation. Employ as an enema one pint to a quart in adults (soapsuds and water and ʒi to ℥i of sweet oil added if necessary, one-half pint in children, less in infants). If tympanites, add ʒss-ʒi spts. turpentine to the enema of an adult. Temperature, 101–102° F. Position dorsal, at times sitting.

2. Stimulation, as in Shock. Normal salt solution (one dram of salt to a pint of water) ℥ii to ℥ vi at 110–120° F. Plain boiled water can be used, but normal salt solution is preferable. Alcoholic stimulants can be added if so desired.

A small enema should be given to prevent evacuation, as this form of enema is to be absorbed. The injection should be given very slowly—a folded towel slipped over the anus as the tip is withdrawn, and the buttocks held together for some minutes thereafter to prevent escape. This can be frequently repeated, often every fifteen minutes or half-hour to an hour or two hours. A saturated salt solution is said to be most efficacious by some authorities; at times as small a quantity only as ℥i can be retained.

3. In uremia (diminished secretion of urine or suppression), to dilute the poison and reflexly stimulate the kidneys to secretion and to eliminate the poison; and also in sepsis, as diphtheria and septicemia, and to replace loss of fluid, as in cholera, etc. Also in post-operative thirst, as after severe hemorrhage. The same method, normal salt solution or hot water, 102°, 104°, 110°, 120° F., depending on the case. Use two to six ounces. We have employed this method recently in acute uremia with suppres-

[illegible]

[illegible] repeated several times [illegible] are in effect [illegible] one-half pint to a [illegible] for which they are em-

[illegible] rectal [illegible] urinary [illegible] relief of [illegible]

[illegible], hot water [illegible] flaxseed tea [illegible] most [illegible] four ounces [illegible] roughly speaking one-half [illegible], and repeated four or five [illegible] 105° [illegible] F. Cold acts [illegible] though there is more fre- [illegible] cold than to heat.

[illegible] four ounces to a pint. [illegible] rhoids.

[illegible], as in acute congest [illegible] lammation of the sem- [illegible] ounces to a half pint [illegible] succession, at a high [illegible] radually increased [illegible] F., or even iced [illegible] oblique, or dorsal [illegible] with shoulders [illegible] ndant gives the

2. In bladder inflammation, four, to six ounces to a half pint (a half glass to a glassful) at 110°–120° F., are generally the best quantities to employ in conditions such as cystitis, irritability of the bladder, frequent micturition, retention of urine, etc.

(*C.*) *In gynecology.* Dr. J. R. Chadwick advocates the use of hot water per rectum, in the treatment of pelvic inflammation. See "Transactions of the American Gynecological Society, 1880."

We recommend six ounces to a half pint, one pint to one quart of normal saline solution at 101°–102° F. during menstruation if insufficient. In pelvic pain, inflammation, etc., the same quantity, but at a higher temperature, at 110°–120° F. Position—dorsal or Sims'.

Dr. Paul Reclus, in the *Medical Week*, Nov. 22, 1895, advises hot enemata in rectal, prostatic, and gynecological conditions; thus in hemorrhoids of recent formation, without marked sphincter contraction injection, of hot water at 55° C. (or 131° F.).

Note.—This seems somewhat hot for comfort. We find that a temperature over 120° F. generally causes some sensation of pain or aching. We advocate a temperature 110°–120° F. as sufficient. The nates and sphincter should be well lubricated to prevent discomfort, when the enema is to be evacuated. Normal saline solution is also preferable as causing less dryness (subsequent) or damage to the mucous membrane.

In acute prostatitis he employs the canula of an irrigator, filled with water at 55° C. He opens the tap, allowing the fluid to escape in small amount; he repeats this several times at a sitting, the treatment being carried out twice a day. The same method is followed in congestion of the prostate,

hypertrophy of the prostate, and retention of urine.

He uses it for the relief of pain on pressure in the vaginal cul-de-sac, infiltrations of this region, menstrual troubles; also in oopho-salpingitis, and perimetro-salpingitis.

5. To reduce temperature, a pint to a quart of water, or normal salt solution at 60–70° F., or even iced water in adults. In infants, half a pint to a pint repeated several times. Care should be taken to avoid shock.

6. To check hemorrhage (a) in the rectum; (b) in adjacent organs, as the uterus. Enema very hot, 110°–120° F., or cold, 50°–60° F., or even iced water (36°–37° F.), one pint to one quart, and repeated several times. Normal salt solution is the best, though simple water can be employed.

7. Mechanical, as in intussusception, as of the sigmoid or descending colon into the rectum.

A fountain syringe is to be employed.

The general methods are the same as in the use of the high enema. Depending on the location of the obstruction, a colon tube may be inserted part of the way or not, or merely the usual tip of the fountain syringe. Also the quantity of the fluid should be less. The same precautions are to be observed, and the technique is practically the same as previously described, pages. An anesthetic is always to be administered.

Nutritive Enemata (water as a vehicle):

Though not strictly under the domain of intestinal hydrotherapy, the question of the nutritive enema is an important one. Such an enema, if unabsorbed may, through the process of fermentation, readily give rise to auto-infection, and then aggravate the [illegible] under treatment. We will cite an example.

A girl, aet. 8 years, suffering with gastro-enteritis, had been given opiates in large doses, and when the diarrhea had been checked, milk slightly diluted with water, had been injected in large quantities into the bowel for nourishment, the family physician ordering these procedures. Dr. William H. Thomson was called in consultation. He found the child had had but one slight movement of hardened material within three days, also evidences of accumulation in the descending colon and sigmoid. There was a furred tongue, high temperature varying from 103–105° F., and a septic appearance. The doctor requested me to irrigate the bowel, and clear out the impaction. This process took about an hour, and we removed over a quart of curdled milk, in various stages of decomposition, some pieces nearly the size of an adult thumb, and of nauseating odor. Considerable fecal matter and bile were shortly passed. The temperature of the child dropped promptly to between 99°–100° F. A second enteroclysis was administered, when the temperature became normal, and recovery was rapid. This demonstrates the importance of proper technique in such enemata, and the dangers of auto-infection.

We believe the administration of small quantities in dilution, and given more frequently, are better retained and absorbed, than a single larger amount. It is often a good procedure, to clear the rectum gently by a small enema given some time, an hour or an hour and a half, before the nutrititive enema. A normal saline solution is excellent for this purpose.

The nutritive enema should be injected slowly, a small, hard rubber hand syringe,—the tip well lubricated,—being a good instrument for this purpose. As the tip of the instrument is withdrawn, a

towel folded into a pad should be pressed firmly against the sphincter, and kept there for several minutes. The buttocks should be pressed together for some time thereafter, to prevent escape of the injection. Holt states that in infants, it may be necessary to do this for an hour. *Note.* A larger quantity can be given, if a long tube is employed, as described after Grandin's method, page ——.

If the bowel is irritable, it must always be washed out before giving the nutritive enema.

In some cases it may be necessary to administer fifteen or twenty minutes previously to the enema, a small opium suppository, gr. ¼–gr. ½, or with belladonna extract gr. 1/16–⅛, or the latter alone; or possibly 1/16–1/24 gr. of cocaine, added to the above suppository, if extreme irritability exist. This last, however, may be contraindicated.

We believe that by washing the rectum an hour or so previously, say with an enema 101–104° F. of only half a pint or pint of water, we can, as a rule, dispense with the suppositories.

Size of Nutritive Enema (*Quantity.*)—From two to four ounces is an average, depending on the case.

A pinch of salt, added to the enema, aids absorption.

Peptonized milk or predigested foods should always be employed, and always well diluted with water. Some of the beef extracts are excellent, such as Mosqueras as recommended by Dr. Holt, several drams.

Somatose one to two drams is good, also Beef Peptonoids (diluted one part peptonoids to seven or eight parts of water), Wyeth's extract of beef, or Armousa, or pure beef juice may be used.

The milk should be completely peptonized.—See Holt.

To peptonize milk—"One pint fresh cow's milk and four ounces of water are placed in a bottle, and a powder containing five grs. extract pancreatis, and fifteen grs. soda bicarbonate added to it. This is kept at a temperature of 105–115° F. by placing the bottle in water, roughly speaking about as hot as the hand can comfortably bear. It should be shaken from time to time. For complete peptonizing, this process should be kept up for about two hours, the water about the bottle being kept hot."

The peptoning powder is sold in tubes, and also in tablets. Fairchild puts up a convenient preparation in tube form. Fresh powders can be ordered, however.

℞ Ext. pancreatis.....grs. 5
Sod. bicarb.....grs. 15
In each powder. Make 12 such, etc.

In preparing the enema, we advocate no stronger than peptonized milk one part, water three parts, or even more dilute.

The white of a raw egg is excellent.

If alcoholic stimulants are employed, they should be no stronger than one part in eight of water to prevent irritation.

Medicines can be administered by enema, and should be well diluted. Those irritating to the mucous membranes as camphor, etc., should not be so employed.

In the succeeding chapters, enteroclysis will be described.

CHAPTER IV.

IRRIGATION WITH A SINGLE TUBE (ENTEROCLYSIS).

We will proceed to describe enteroclysis. The methods of intestinal irrigation which are now employed are, first, "Irrigation with a single tube," and, second, "Double-current irrigation" (with two tubes, or a double-current tube), the most recent and, as it would seem to us, the more scientific procedure of the two. The present chapter we will devote to "Enteroclysis with a Single Tube." This may be (*a*), high, as of the colon, or, (*b*), low, as of the rectum.

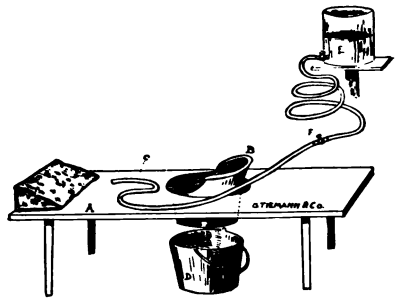
Several methods are employed.

(*a*) *High Irrigation.*

Method 1. In the adult—a single long tube of soft rubber (flexible) is employed. This may be the regulation colon tube, or a large catheter, with an extra opening, made under the tip. This is warmed after thorough cleansing, lubricated, and inserted gently twelve to eighteen inches. A fountain syringe is attacned, or a funnel, as lavage. A definite quantity is allowed to flow in, and then the tube of the fountain syringe is detached, and the escape of the fluid permitted; or the funnel is lowered to below the level of the patient. This process is repeated as often as is necessary. The patient is in the dorsal position, or better, in the same posture with the hips elevated. Some place the patient on the right or left sfde. The tube enters more rapidly, if the fluid is allowed to flow in while inserting it. The temperature should be at 101–105°

F. in the average case. At times cold is preferable at 70–90° F. About a pint to a quart and a half are employed in the bowel at a time, and several bagfuls of solution are used, or, in some cases, washing is carried on until the return is clear. In advanced cases of typhoid, or dysentery, about half a pint to a pint might be placed as the limit of safety, taking advantage of position, to secure thorough cleansing of the bowel. In the method just described the operator does the work, and the patient is passive, and does not endeavor to void the fluid.

FIG. VI.



Elmer Lee Irrigating Station.

The indications for this method, are to aid in softening and removing impactions in the large intesttine, colitis of the various types, dysentery, diarrheas, and that, too, even of small intestine, to remove infectious material in typhoid, cholera, etc.

Method 2.—By allowing the patient to void the fluid himself, and then the washing is immediately repeated and so on; a continuous irrigation in effect. This method can be employed with best results for cleansing purposes, and also in shock, uremia, and hemorrhage. It is similar to enteroclysis of the

infant (see Fig. 6) Elmer Lee's cholera station irrigating apparatus, as shown in Dr. Baruch's *Hydrotherapy*, is here illustrated.

Irrigation with a Glass Y Attachment.

Method 3.—Attach a glass Y to the rectal tube. To the upper branch, attach the tube of the fountain syringe, and to the lower the carry-off tube. Pinch

FIG. VII.

Enteroclysis (Single Tube) of Infant.

the latter, and allow a definite amount of fluid to flow into the bowel. Then by alternately pinching the inflow and outflow, irrigation can be carried out without detaching the fountain syringe. This is a convenient method.

The following corresponds to the second method.

Irrigation of the Infant Colon with a Single Tube.

We can do no better than to quote Emmet Holt, in

his recent excellent work. He places the ileocecal valve as the limit the fluid may reach. "The child is placed on the back, thighs flexed, buttocks brought to the edge of the table, clothing protected. The fountain syringe at a height of 4–5 feet; a flexible rectal tube, or a soft rubber catheter, No. 18–20, American scale, is employed; an extra eye may be cut near the tip. The catheter is oiled, and just after the tip is inserted into the anus, the water is turned on. This renders it stiffer and it passes more readily. It is pushed in 12-14 inches.

Another method, is for the nurse to hold the infant on her lap, as in the illustration. The thighs form a trough, and the rubber sheet spread over the lap acts as a funnel, to conduct the fluid into the foot-tub or basin. The head of the child rests on the nurse's lap, her elbows restrain the infant's arms, and she holds up the thighs with the knees flexed. A small footstool should be placed beneath the nurse's feet, to secure the proper position of the infant, and for her own comfort."

The peculiar curve and length of sigmoid flexure, Holt believes, makes the introduction of water difficult, unless the tube is passed to the descending colon. Usually a pint, and often a quart, will be introduced before any water returns. The water is passed from time to time alongside the catheter, often with considerable force. The operator may hold the tube in situ, and a towel should be spread over the hand, and fall like a screen in front of the anus, to prevent wetting, by the sudden forcible evacuation of the fluid. At least a gallon of water in divided quantities, should be used for a single irrigation. The washing should be continued until the water returns quite clean. Gentle kneading of the

abdomen should be continued during the irrigation, particularly the early part of it, to facilitate the passage of water into the upper part of the colon. The temperature of the fluid in most cases should average 101° F. At the end of the irrigation, the tube of the fountain syringe is detached, and the water allowed to escape through the catheter, which remains in situ. Sometimes as much as a pint of water remains in the intestine. This is usually passed within half an hour, as an irrigation of the colon almost invariably excites peristalsis of the lower ileum. This is emptied as well. The colon of a six-month infant, holds a pint without distension, and at the age of two years, two to three pints.

Irrigation of the colon, is useful to clear this part of the intestine of mucus, fecal matter, undigested food, and the products of decomposition. It may be employed as a means of local medication in ileocolitis. Where the object is simply to cleanse the intestine, a saline solution (one dram of salt to a pint of water) is preferred.

(b) *Low Irrigation with a Single Tube.*

Irrigation of the Rectum: This may be carried out with the fountain syringe, detaching it from the rectal tube at intervals, or with the funnel, or glass Y, just as in high irrigation; or as with infant enteroclysis. A soft rubber tube or catheter; is inserted into the bowel, but only for the distance of three or four inches. Another method is to employ a hard rubber tip about three inches long. Insert it into the bowel, and allow the patient to pass the fluid out around the tip, thus keeping up a continuous flow. Following this method, we should prefer the patient in a [illegible] position. In prostatic conditions or hemorrhoids, a sitting (semi-oblique) position is

often convenient. This method is applicable to many inflammations of the female organs, prostate, bladder, in proctatitis, hemorrhoids and other rectal conditions, etc.

Dr. Hanks, of this city, has also employed it for years past in uremia, shock and sepsis. Under the latter conditions, the dorsal position would be preferable, hips elevated. Temperature of the fluid should be on the average 101–105°, as in proctatitis. In shock and hemorrhage normal saline solution always at 110–120° F. A high temperature, at 110–120°, is also preferable in gynecological and genito-urinary conditions.

In infants, normal saline solution should be used, and similar methods are employed.

In intestinal catarrhs a temperature of 101–105° F. and half a pint to a pint of solution at a time. If much fever cold irrigation, 60–90° F., or even iced water can be used, but with caution; avoid cold if there are renal complications.

In acute catarrhal proctatitis a bland fluid should be employed, as starch water, lime water, a mixture of oil and lime water, or a warm normal saline solution.

If there is a local cause, as worms, it should be removed.

In the more chronic cases, saline injections can be given, followed by astringents, as tannic acid, ten grains to one ounce, or a one per cent. solution of hamamelis.

In membranous cases, warm boric acid solutions can be used in addition, ʒss–ʒi to the quart.

The Quantity of Fluid.—The quantity of the fluid to be employed depends on the nature of the case. In proctatitis in an adult Oi to i quart; in an infant

Oss–O1 at a time, and repeated until the return is clear.

In gynecology the same quantity.

In genito-urinary cases the average quantity injected will be found to be from ʒiv–ʒvi–Oss.

A convenient method in these cases is to void the fluid himself about the tube. He should endeavor to allow about ʒvi–ʒvii to enter, and then the entering current should be checked an instant while the effort of expulsion takes place. The escape occurs around the tip and the inflow is then started again. The tip, is not removed. We direct roughly a cupful of normal saline solution to be injected at a time and repeated 6 to 8 times in succession.

In the succeeding chapter, we will discuss the latest tecnique of enteroclysis by means of the double current tube.

CHAPTER V.

ENTEROCLYSIS (Continued).

Double-Current Irrigation.

The third subdivision of intestinal hydrotherapy is double-current irrigation, or continuous irrigation, with two tubes or a double-current tube.

This method is the most recent, and seems to be the ideal as a rule. The principle, however, is quite old. The instrument devised by Bodenhamer is probably the first known double-current rectal irrigator.

FIG. VIII.

Bodenhamer.

It is only about three and a half inches long, and was employed for rectal irrigation as well as for the treatment of hemorhoids, etc. It is readily understood from the photograph, Fig. 8.

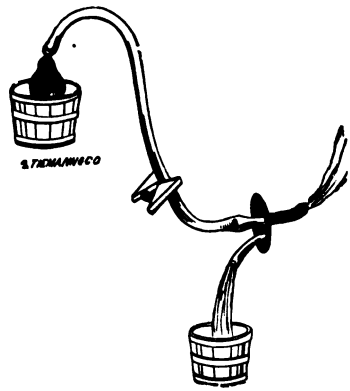
For colonic or rectal irrigation, the late Dr. Henry B. Sands employed two tubes or catheters side by side.

Others have used two tubes or catheters, of unequal size, the larger for the return flow. Hare also mentions this method. The late Dr. J. West Roosevelt improvised a catheter passed through a colon tube, and out of its open end, and then cut lataral

openings in the colon tube near its tip, the central catheter for the entering current, the outer colon tube for the rectal flow. Others have employed large double-current catheters.

For reference, we give plates of the best known irrigators. These will explain them most easily. Mention will also be made of those tubes of which no illustrations could be secured.

FIG. IX.



Siphon.

The average length of most of these irrigators is 5–6 inches.

Note.—Some of ene's irrigators have a number of small openings at the tip for the entering current instead of as in Fig 12.

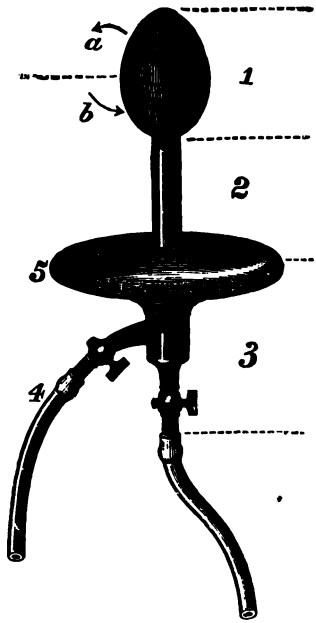
Smith's instrument is practically a self-retaining rectal speculum.

Note.—Mundes' instrument is a light wire rectal speculum, which keeps the sphincter patent and allows a continuous irrigation of the rectum to be carried on. Strictly speaking, it is not a double-cur-

rent instrument. He employs the same method in the vagina,

Matthieu has devised an irrigator practically the same as Bodenhamer's. An opening at the tip and lateral perforations in the body of the instrument.

FIG. X.



Clendenning.

The arrangement at the outer extremity differs in in appearance from Bodenheimer's, being crucial in form.

Rectal Tip with Septum.—There is a double current tip (inventor unknown.) It consists of a short hard-rubber tip divided by a septum. A catheter is

passed through one side, well up the bowel, and the the outflow passes down the intestine and out of the other side of the tip.

Of Prince Morrow's rectal irrigator, we have no

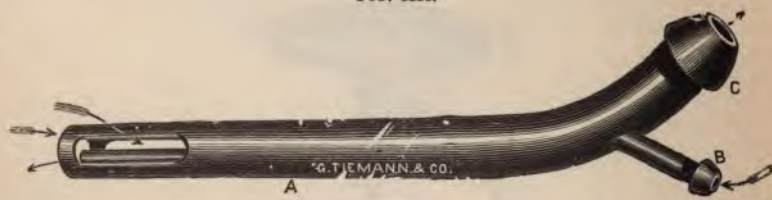
FIG. XI.

Martin.

plate. The entering current sprays backward from the tip; otherwise it is much like Bodenhamer's.

Chetwood's Rectal Irrigator for the Prostate.—He

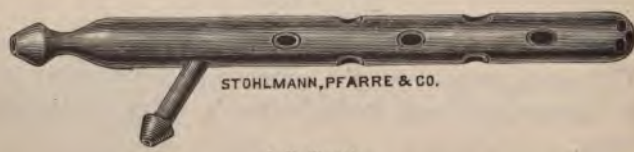
FIG. XII.



Skene.

has two models. In one there are several openings at the tip with which a central tube connects, also numerous small lateral openings into the outer (skin)

FIG. XIII.



J. P. Tuttle.

tube. The second model is also of glass, of uniform caliber, one opening at the tip and numerous side

openings. It is suited only for prostatic irrigation, as it is short and the openings too small for the removal of foreign material.

Kemp's Old Models.—Our own instruments were first reported December 7 and 14, 1895, *New York Medical Record.* In these, the inflow current passed through the central tube, and entered the bowel on the upper surface of the instrument by an oval opening just behind the tip. The outflow opening was below, and of larger size, and the fluid returned through the outer (skin) tube, and passed out through the curved outflow tube in the cap.

The fountain was attached to the central tube, and the soft rubber carry-off tube to the curved outflow tube (see Fig. 20, the model for the hard rubber irrigator, five inches long.)

It was employed successfully in colitis, also in rectal conditions. In one case of acute uremic suppression, in which continuous irrigation was employed for a considerable length of time, with normal saline solution. These cases were reported in the *Medieal Record*, December 7, 1895. The uremic case occurred in August of that year (1895). The other cases were catarrhal colitis, croupous colitis, enlarged prostate with irritable bladder, congestion of rectum, etc.

Section looking from above shows oval opening on upper surface of instrument, near the tip for entering current, and one larger oval opening below for the return current.

Two openings just back of tip, one on upper surface, one on lower surface, both of these for entering current. Two lateral openings, opposite each other, for return current. These lie about an inch further back.

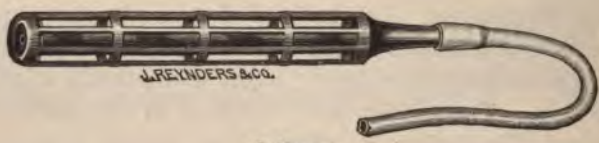
Finding the current not entirely satisfactory, we made changes in the original instrument, having two lateral openings for the return flow, just behind

FIG. XIV.

Sims.

the tip and opposite each other. The inflow current entered the bowel as before, through an oval opening

FIG. XV.



Colemans.

on the upper surface of the tip. This modification was made for us by the Ford Instrument Co. in the Spring of 1896 (see Fig. 21 above.)

FIG. XVI.

Coleman's (Improved).

Later (Fig. 23,) we further changed the old model having two openings at the tip and two laterally.

Guiteras' Rectal Irrigator for the Prostate, Fig. 22.

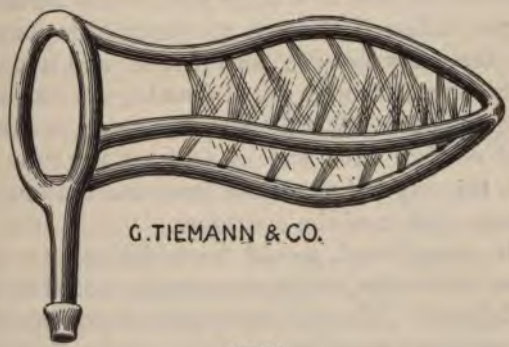
This irrigator was recently devised by Dr. Ramon Guiteras, of New York It has a slight prostatic curve to the tip, and on its upper surface is an oval opening for the current to enter the bowel. A short

FIG. XVII.

Mundé.

distance behind the curved tip are two lateral openings for the return flow. It resembles Fig. 21, except for the curve.

FIG. XVIII.



Smith.

*Long Flexible Double Current Tube for High Irrigation of Bowel, also Double Current Irrigators for Infants.**

This flexible irrigator is a modification of the soft-rubber rectal irrigator, described in the *Medical*

**New York Medical Record*, December 14, 1895.

Record of December 7th, 1895. The outer tube is of soft rubber, diameter five-eights of an inch; the inner longitudal tube is of linen. The linen tube is riveted in a hollow tip, and this tip unscrews from the outer tube, etc.

This irigator was twelve inches long. There was also a smaller size flexible irrigator for infants, eight inches in length; there was also a soft rubber tube (rectal), with central tube of copper, which could be curved to suit.

Figs. 24 and 25 show the openings of the large and small irrigators at the tips.

In the *Philadelphia Medical Journal*, May 19, 1900, we note an irrigator recently invented.

It is called "The Artificial Defecator and Irrigator," by Dr. Robt. M. Barger.

The central tube is of large size, and is for the outflow, the inflow is through the outer (skin) tube between the walls and the central tube, and it escapes into the bowel through small openings in the tip of the instrument. This tip acts as a valve, to close the central outflow tube, and as soon as the tube is inserted, this cap is forced free from the outflow tube by manipulation of the operator.

It is complicated, would seem difficult to clean, and we believe the mucous membrane would be liable to be injured. We shall devote the following chapter to our latest technique in enteroclysis, eliminating in so far as possible former errors, and describing what we believe to be the most practical, as well as the most scientific method of intestinal irrigation, and which we shall denominate modern enteroclysis.

CHAPTER VI.

MODERN ENTEROCLYSIS.

Double Current–Irrigation

(With Two Tubes, or a Double-Current Tube).

Before we enter into a description of our latest instruments and technique, we believe it to be only fair to our readers to explain as clearly and succintly as possible, the reasons for our belief that enteroclysis with the return flow tube (double-current) is the most scientific as well as the most practical method of which we have present knowledge. They are as follows: The temperature can be kept even and constant, and the fluid does not cool, since fresh hot fluid is continually entering to replace the cooler, which passes out.

Its value therefore in shock and allied conditions is evident.

The temperature as well as the quantity of the fluid are both under the control of the operator, since they can be regulated by proper manipulation of the inflow and outflow tubes.

The labor is placed upon the operator and not upon the patient, and the material can be washed out, and there is no straining to overcome the resistance of the sphincter. Thus if a feeling of discomfort or a desire to evacuate occur, immediate relief can be secured by shutting the inflow and allowing free outflow. The straining of self-evacuation may thus be avoided if so desired, and mere mechanical cleansing of the bowel be employed.

A continuous irrigation may be given for a long period; frequently we have employed an hour or more.

Tympanites of the most obstinate type is relieved best of all by this method, the return flow carries off the gas by suction, on the principle of the Sprengel's air pump. With the ordinary enema the gas frequently collects in the intestine behind the injection like an air buffer, and it is often impossible to exert

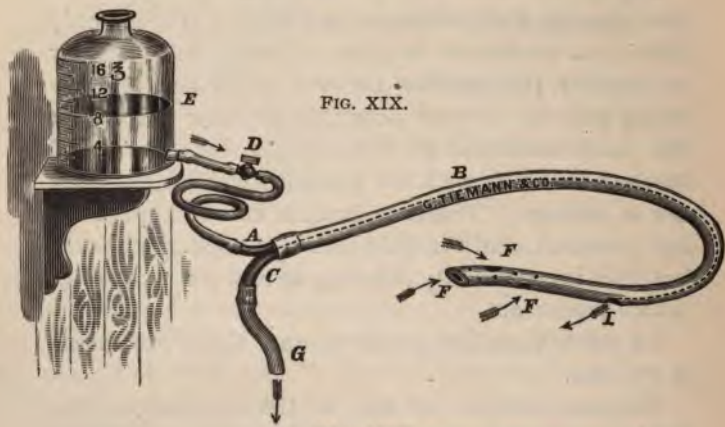


FIG. XIX.

Hemmeter.

sufficient force to expel gas and enema. The continuous irrigation can be given, even if there is complete relaxation of the sphincter (incontinence), by passing the tube or tubes through a perineal pad, and exerting firm pressure thereon.

The long-continued heat and even temperature rendered possible by this method, exerts a much better effect for stimulation. The same holds true as regards the effects on the genito-urinary system.

In intestinal paralysis, especially post-operative,

etc., we obtain better results as a stimulant to peristalsis of the intestine.

Even in diarrhea, etc., the continuous enteroclysis

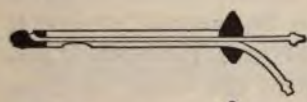


FIG. XX.
Kemp (old model).

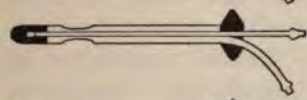


FIG. XXI.
Kemp, same modified, 1896.

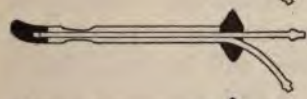


FIG. XXII.
Guiteras' Prostatic Irrigator (Rectal.)

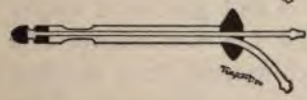


FIG. XXIII.
Kemp (old model) further modified 1896.

seems to clear out the intestines with greater speed, by causing the small intestine to empty itself more rapidly into the large intestine, and the reflex effect

FIG. XXIV.

Kemp.

caused by the continuous flow seems more active. We have already noted some of the simple devices—such as two catheters, or a catheter within a colon

FIG. XXV.

Kemp.

or stomach-tube, the lateral openings being cut in the latter, and also the employment of a double-

current catheter. We suggest the following as a useful method in emergency.

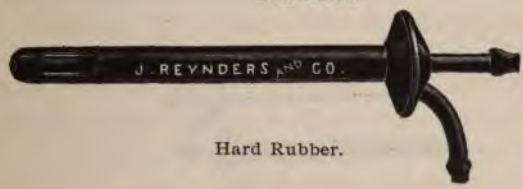
To Improvise a Double-Current Irrigator.—A simple method to improvise a double-current irrigator (emergency) when none can be secured, or time is an important factor, is as follows: Take two catheters, one of larger caliber than the other, tie them together with fine cotton or silk, or sew them together in several places, and pressed together so as to adhere sufficiently to be introduced. The tip of the smaller catheter may project one or two inches above the larger, so the inflow will be on a higher level than the outflow; also it will give us a longer portion projecting externally for convenience of a carry-off tube, or to pass completely into the bed pan so as not to wet the patient. The eyes of the catheters should be directed laterally outward. The catheters should be joined only for about two-thirds their lengths. This improvised irrigator should be passed through a perineal pad of gauze or cotton, covered with oiled silk, or a piece of oiled cloth or a dress shield, and then inserted in the bowel. This pad enables us to keep fluid in the bowel, even if there be incontinence. The outflow tube should be the larger for the escape of mucus, etc., and also to enable us to regulate rapidly the quantity in the bowel. If the larger tube be left patent, no fluid will pass up the intestines.

If only drainage tubes be at hand, the rough edges can be trimmed off, and then by heating over a flame and wiping quickly with a moistened finger or cloth, one can secure a smooth and rounded margin.

We will now describe the later models of Kemp's irrigators. Though often of the same general model they are made of different materials, so to be either

stiff or flexible, according to indications. The instrument possesses certain advantages, as it is simple in

FIG. XXVI.



Hard Rubber.

construction, readily cleansed and has given excellent results in its clinical application. See *New York*

FIG. XXVII.

Glass.

Medical Journal, March 13, 1897, and January 29, 1898.

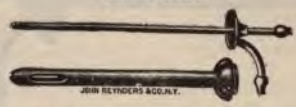
FIG. XXVIII.

Flexible.

Note.—This last tube has been modified by having the outer tube of hard rubber and the inner tube

of metal. This gives us a double tube, and one in which the soft parts are protected from the heat—a fault in the metal tube which had to be remedied by protecting with adhesive plaster at the sphincter.

FIG. XXIX.

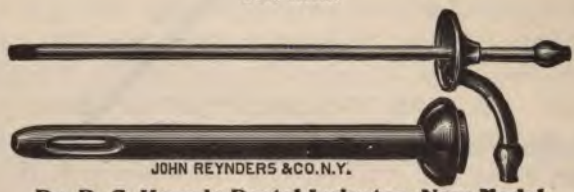


Metal Ready for Cleansing

Description of the Instrument.

The irrigator is made on the principle of a tube within a tube, the central tube opening at the apex of the instrument, and passing through a cap which, when screwed in position, closes the outer extremity

FIG. XXX.



Dr. R. C. Kemp's Rectal Irrigator, New Model.

Outer tube, hard rubber; central tube of metal.—Hard Rubber Flange, protecting Sphincter from transmission of heat, through the metal parts.

of the outer tube. To the cap is attached the carry-off tube, and this opens into the outer tube. The curved tube is of larger caliber than the central tube. There are two lateral openings in the outer tube. In the cut (Fig. 27) the glass irrigator with a cork opening above the oblique tube is shown; also the hard-rubber irrigator, the upper tube (Fig.

26). In this the cap unscrews and also the central tube which is to be withdrawn when the tube is cleaned. Some of the glass tubes have no cork opening, and in these the return current should always be through tne center. The third tube(Fig. 28); the longest in the cuts, is the model of the soft rubber irrigator, either stiff or flexible, and also of the colon tube. The stiff tube is of soft rubber externally, with a metal central tube. This can be given a curve to suit the operator. The flexible tube is of soft rubber externally, with a linen central tube made from a cheap stylet catheter. The colon tube is 12-4 1 inches long and made like the flexible rectal tube.

The average length of the rectal irrigator is five inches and the diameter three-eighths inch. The soft rubber instruments vary from three-eights to five-eighths of an inch in diameter.

A flexible infant tube is made three-eights of an inch diameter, four inches long; also an infant colon tube. The adult flexible rectal tube inserted part way is safe for infants.

We have the following five tubes to fulfill practically all the clinical indications.

First, The hard rubber double-current rectal irrigator (adult size).

Second, The metal double-current rectal irrigator (adult size). This is described in the *Medical Record* July 24, 1897. A rubber collar will protect the sphincter if heat is complained of, or adhesive plaster. The tube is durable and can be boiled.

Note.—With rubber, vulcanized, or metal tube—when the rubber became hot it cracked on account of the unequal and forcible expansion of the inner metal tube.

Third, the rectal irrigator (latest model, 1900)

outer tube and cap of hard rubber, inner tube of metal, screwing into rubber tip and rubber cap. The inner sphincter and bowel, are thus protected against the heat, and the tube is also extremely durable. We consider it the best of the stiff irrigators.

Fourth, Soft rubber double-current rectal irrigator with a metal center, also adult size. This can be bent to suit, and is excellent in cases of enlarged prostrate or uterine tumor partially obstructing the rectum, since, after examination with the finger per rectum, the proper curve can be secured.

Fifth, The soft rubber double-current rectal irrigator, (flexible), also of adult size. This is excellent in sensitive cases, or in infants and children. It can be thoroughly softened in hot water and inserted only part way—about half its length. It gives a better current than the infant tubes. At times we employ the flexible rectal tube for infants This is infant size and good in very sensitive cases. The central tube is generally made of a linen catheter. We have found the flexible English catheter (such as has the stylet) much more durable. The ends do not fray as readily, nor does it crack as easily. No. 7 is a good size. It can be cut in lengths to suit, and the hard rubber fittings will cut their own thread on it.

A fresh central tube can thus be used in every case, and the outer soft tube and the hard rubber fittings can be carbolized. Perfect cleanliness can thus be secured. Boiling is liable to damage the rubber fittings.

We employ the latest model hard rubber external tube, metal central tube rectal irrigator which we consider the best; also the hard rubber rectal irrigator. In infants or children or sensitive cases, we

use the adult (flexible) rectal irrigator. This may excite surprise—the employment of so large a tube on infants—but is softened in hot water and inserted only part way. The outflow is large, which is a great advantage, and if we stop to consider, we find that the infant frequently passes large, hardened fecal masses, of much greater caliber than the soft irrigator. We have never experienced any difficulty in its use, nor caused pain, nor has trouble resulted. In special cases, however, an infant size (rectal) irrigator might be employed.

We no longer use the colon tube in enteroclysis, but the rectal irrigator, in conjunction with placing the patient in the proper position. One can wash the bowel as thoroughly with the five inch tube by this method as with the colon tube. In this connection we would call attention to the following:

The adult rectum averages 8 inches in length, and the adult sigmoid 17½ inches. The mesentery of the sigmoid is often very long, allowing that viscus to be readily pushed up. Thus to enter the descending colon where it joins the sigmoid flexure—(in an adult), a rectal tube 28–30 inches long is necessary; for allowance must be made for the sphincters and for space to insert the tip of the fountain syringe. It seems a curious fallacy, how we hear prominent physicians, in our well known society meetings, describe entering the colon—(even at times to the transverse portion) with the average rectal tube. Such a tube is 18 inches—rarely two feet in length. We have never seen one of sufficient length, to enter into the adult colon. Dr. Howard Kelly speaks of the sigmoid being pushed up frequently by the tube, and that the entrance into the colon is thus simulated. On the other hand, the infant sigmoid is only about

three and a half inches from the sphincter, and the above statement does not apply. The position of the patient is therefore the main factor to be considered in enteroclysis.

TO CLEAN THE IRRIGATORS.

Hard Rubber Rectal Irrigator Metal; or Latest Model.—Unscrew the outer cap, and with it the central tube and then withdraw the latter.

Flexible Irrigators.—The flexible short tubes or colon tubes should be cleaned as follows: Unscrew the accessory cap and loosen the main cap, pushing them along the central tube to nearly its ends, and holding the outer rubber fitting of central tube firmly meanwhile, to prevent twisting the soft tube; then withdraw the hard rubber tip from the main outer tube, and with it, about half an inch of the central linen tube; then unscrew the tip and holding the catheter firmly just below it, withdraw the central tube, as in the above instruments. If the attempt were made to unscrew the flexible tube, it might be easily torn through.

The flexible tubes should not be allowed to remain in any solution, except for a moment, as the central tube readily softens and collapses. Should this occur, a wire passed through it, will generally remedy the difficulty.

Reservoir for Irrigating Fluid.—The fountain syringe of a capacity two to three quarts is most convenient.

The Best Method of Attachment.—If the fountain syringe is attached to the central tube, and the carry-off tube to the larger lateral tube, the current is more forcible, and also the outflow is more free for mucus,

etc. A soft rubber tube is attached to the curved tube, the length depending is to be conducted into a bed-pan or a vessel on the floor. By alternately pinching this and the tube of the fountain syringe, the quantity of fluid entering and escaping can be regulated. Unless the outflow tube is compressed, no water can pass up the bowel except for a few inches, as it is of much larger caliber than the inflow.

Occasionally the following method is employed, as in some of the glass irrigators:

The tube of the fountain syringe is attached to the curved tube, and the current enters by the lateral opening, and returns directly through the central tube. A soft-rubber tube is attached to the central tube; this method is also employed in those tubes made with the central tube of large caliber.

The first method described is the best.

Precautious before Insertion of the Tube.—First, allow the irrigating fluid to flow from the tube, so as to force out all air, and then check the flow. Second, as the tip of the instrument passes through the sphincter into the bowel, it is well to start the flow, so force the mucus membrane away from the irrigator and fenestræ. Also the entrance of the tube is not interfered with by the resistance of the mucus membrane.

Insertion of the Instrument.—1. The tube should be well lubricated and inserted with a gentle rotary movement, the tip directed slightly backward toward the sacrum and not forced in; this is especially the case with the hard tubes.

Forcing the tube in, might injure the mucus membrane. Do not press the tip of the tube against the wall of the bowel, or direct the current against it, as either is irritating.

2. If the flow ceases, rotate the tube slightly, or withdraw it slightly while rotating, and push it back. If the return tube seems plugged, attach the fountain syringe to it for an instant, and force the current in the opposite direction.

The best method to clear the outflow tube is as follows: A small, hard-rubber rectal syringe (enema), which contains from half an ounce to an ounce, is to be employed. Shut off the entering current, and then force water back into the bowel through the outflow tube. This will free it from the obstruction.

Length of Insertion of the Irrigator.—The rectal tube should be inserted one-third to one-half its length in prostatic cases, etc., and full length for high irrigation.

N. B.—Clinically the short tube inserted full length, and the patient with hips elevated, gives as good results as the colon tube for a high irrigation.

Withdrawal of the Instrument.—Do not withdraw the instrument like an ordinary tip, as the mucus membrane might catch in the fenestræ. Withdraw it gently, and while doing so, rotate it slightly first in one direction and then in the other. This prevents the above accident and frees the tube if it has occurred.

Note.—Certain objections have been made to the tube with the two large fenestræ, chiefly that the mucus membrane is apt to catch in them, and injury to it result as well as pain to the patient. Therefore tubes with numerous small openings are advised, also the forcible gushing of fluid through these openings is apt to carry into them the mucus membrane. These accidents are due to faulty technique.

The tubes are purposely made with large openings for "all round work," so mucus, etc., can escape.

The tubes with small openings are not practical for this purpose. The sudden gushing of the fluid can be avoided, by pinching the outflow, so that the flow is steady. Overdistention and straining therefrom are also a cause of this, and the quantity of fluid in the bowel should be regulated properly.

Some patients are sensitive, and can only retain a small amount at first, and this must also be taken into consideration.

The physician should personally inspect the tube before allowing the patient to use it, as many poor tubes are made, some even with sharp edges to the fenestræ.

The patient should be instructed in the use of the tube by the physician, or a nurse at least once, if he is to employ it himself.

If there is pain or difficulty in inserting, it is good practice to make a rectal examination to see if there is any obstruction, thus as an enlarged prostate, uterine, fibroid, etc.

Position of the patient—A. In low irrigation:

1. In prostatic cases, etc.: patient sitting upright, or semi-oblique, or in the dorsal position, with shoulders higher than the hips, or on the side with the shoulders elevated.

Note—We have devised a method of self-irrigation of the prostate, which is simple and and convenient, and of which a minute description will be given in connection with enteroclysis in genito-urinary conditions.

2. Enteroclysis in the semi-oblique (half sitting posture). Dr. William H. Thomson's method—This was employed in pulmonary edema or pleurisy with effusion due to oliguria. When on account of respiratory difficulty the patient cannot lie down,

a rectal irrigation is given, the tube passed through a perineal pad and the latter held firmly to prevent the escape of fluid. Fig. 31.

B In high irrigation there are five methods:

1. Dorsal position—hips elevated, shoulders at lower level; on bed-pan, preferably a douche-pan. Fig. 32.

FIG. XXXI.

Enteroclysis in the Semi-Oblique Position.

2. Patient on right side—hips elevated, shoulders at lower level.

3. Patient on left side—hips elevated, shoulders at lower level (practically Sims' position). Fig. 33.

4. Enteroclysis in the dorsal position, on a rubber sheet and without a bed-pan. Fig. 34.

A Kelly's pad can be employed, or a rubber sheet folded and arranged in gutter shape to conduct the fluid that may escape into a foot tub or basin. The

patient should be brought to the edge of the bed, and the latter may be tilted by elevating the opposite side on two chairs. The rubber sheet should be covered with a Turkish towel and a wad of gauze, or cotton placed just beneath the anus to absorb the leakage. The fountain syringe tube passes between the legs and is attached to the central tube of the

FIG. XXXII.

Enteroclysis in Dorsal Position on Bed Pan.

irrigator. The curved outflow tube looks toward the edge of the bed, and to it is attached a long soft rubber carry-off tube which passes into the receiving basin. This outflow tube passes beneath the thigh of the patient, and pressure on it is prevented by folding a large towel and placing it beneath the thigh at the lower third. The attendant sits on a low chair or stool and regulates the inflow and out-

flow beneath the bedclothes and without exposure of the patient. If the bed cannot be tilted the mattress can be bolstered up beneath from the middle of the bed, giving an inclined plane to the outer margin. In case of shock or in any condition when it is inadvisable to lift the patient on a douche-pan, this method is excellent. The foot of the bed may be

FIG. XXXIII.

Enteroclysis in Sims Position.

readily elevated on blocks, bricks, or two chairs, if so desired.

5. Method by rotation:

a. Patient is placed on the left side, with the hips elevated and the descending colon is irrigated freely.

b. Then rotate the patient gradually to the dorsal position, and then to the right side, with the hips elevated; the return tube being pinched, about a pint and a half of fluid is allowed to run into the bowel.

c. The shoulders are then elevated to above the level of the hips, patient still being on the right

Enteroclysis in Dorsal Position Without Bed Pan.

side. This is to make the fluid gravitate into the caput coli.

d. The shoulders are then depressed to below the hip level, the patient on the right side, is gradually rotated to the dorsal position and then to the left side, etc. In other words, the process is reversed. The return tube is then let go and the fluid is allowed to escape.

We employ most frequently the dorsal position without the bed pan (see Fig 34).

The dorsal position, with the hips elevated, will be found convenient as a rule. The position on the left side is also convenient, but avoid this if much tympanites exists, as the escape of gas is not as free, due to torsion of the intestine, and pain is frequently caused.

In the method by rotation, by percussion and succussion, we can demonstrate that the caput coli can be irrigated with the short tube, if proper advantage is taken of the patient's position.

Note—Dr. Egbert Grandin states that he has seen the fluid pass through the large intestine to the caput coli, and back through the large intestine; in other words, a continuous irrigation of the entire large intestine. Enteroclysis was given with normal saline solution for shock during laparotomy, the hips being elevated. The patient was emaciated and the intestinal wall was so extremely thin that the fluid could be easily seen. The five-inch tube was used in this case. This is certainly an ocular demonstration.

Temperature of the Fluid in Enteroclysis. This varies markedly and depends on the condition for which it is employed. The temperature will be given in each class of cases in which enteroclysis is indicated.

SOLUTIONS EMPLOYED. Solution A., Flaxseed Tea. Formula: Two drams of flaxseed to a quart of water, boiled 20 minutes to ½ hour and strained (Dr. Francis Delafield's formula). Temperatures, 101–103°. This should be rather thin and oily in order to flow easily from a fountain syringe. Dilute with it boiled water if too thick.

Solution B.—Normal salt solution. A dram of salt to a pint of water.

Solution C.—Normal salt solution with oil of peppermint, 5 to 15 minims, or oil of cinnamon, 5 to 15 minims to the pint (Dr. William H. Thomson's formula.

Solution D.—Plain boiled water.

Solution E.—Boric acid, half a dram to one dram to the quart, occasionally to the pint.

Solution F.—Permanganate of potassium, three to ten grains in two quarts of water. This is an extremely mild solution.

Solution G.—Bichloride of mercury (1-10:000); two quarts of this solution.

Solutions A, B, C, and D have been used continuously for considerable periods of time, even to an hour. Solution E, two to four quarts once or twice a day. Solution G, two quarts, once a day for three successive days, as in croupous (membranous) colitis; thus reported with excellent results in cases following typhoid fever, etc.

Normal saline solution is preferable to plain water as it does not dry the mucous membrane nor injure the epithelium.

We append a further list of formulæ of solutions employed in enteroclysis:

Listerine ʒi to the quart as an average.
Borolyptol ʒi to the quart " "
Borax ʒi to the quart " "
Sod. Bicarb. ʒi to the quart " "
Alum (pulv.) ʒss–ʒi to one or two quarts.

℞ Sod. borat.....ʒi
Tinct. benzoin.....fl ʒi
Spts. camphor.....fl ℥i
Hot water.....1 quart

In dysentery characterized by bloody evacuations of moderate severity. See Hare's "Text-book of Practical Therapeutics."

Note.—We do not care to employ the spirits of camphor as it is irritating when given by injection.

Hare advises 1-5000 bichlorid of mercury solution in dysentery when there is mucus and pus, to be followed by an irrigation of warm water to prevent an absorption of the mercury.

This strength was employed at the hospital at Oran in over 50 cases with excellent results. See *International Medical Annual*, 1893.

We believe the 1:10,000 solution is efficacious, and is safer.

Others recommend in dysentery:—

℞ Zinc sulphocarbolate.....grs. 15
Water.....1 quart

Use two to three quarts; or,

℞ Acid tannic.....ʒi
Water.....O1

Use two to four quarts.

Lubersohn, (see *International Medical Annual*, 1895).

℞ Boracic acid solution (4 per cent)...ʒiv
Tannin.....grs. x
Tinct. opii.....3¾ m
Tumblers of water (boiled)....1 to 1½

Inject, retain, and then rejected every 3 hours in acute dysentery, practically an irrigation.

Rovacs employs 1:1000 quinine irrigations in ameboid dysentery.

Note.—Weak carbolic solutions have been suggested, but we do not advocate them.

In cases of dysentery some advise a stronger solution of permanganate of potash (grs. x to grs. xx to O1). Use 2 quarts; or, if there are old chronic ulcers: nitrate of silver grs. x, to grs. xx, to O1. Use 2 to 3 quarts, and follow this by an enteroclysis with normal salt solution to prevent too severe an action of the silver, and as an antidote.

We prefer weaker solutions., grs. x nitrate of silver to the quart followed by saline irrigation.

Height of douche bag.—About three to five feet above the patient.

Quantity of fluid.—This depends entirely upon the case in which it is is employed. In colitis, etc., several ounces (four to six) up to a pint to one and a half pints should be allowed to flow in before escape is permitted. To irrigate the caput coli, the method by rotation, employing about a pint to a pint and a half at a time seems most satisfactory. In shock, anemia, intestinal paralysis, etc., about a pint to even a quart should be kept continuously in the intestines. In low irrigation, as in prostatic cases, two to four to six ounces to eight ounces should be kept in the bowel continuously; in gynecological cases ʒiv to O1, depending on the case. In catarrhal appendicitis, irrigation in the dorsal position with the hips elevated is the safest. Later, when tenderness has disappeared, use the method by rotation.

"Dorsal Position" will be found in general, best for a high enteroclysis.

General Medicine.—Case 1. Simple catarrhal colitis. Solutions A. B, C, or E, 2 quarts daily if necessary at about 101-105° F. Solution A, employed by Dr. Francis Delafield. Solution C, employed by Dr. William H. Thomson.

At times enteroclysis may be employed twice daily, in other cases every other day or only once or twice a week, according to indications. Solution A (flaxseed tea) seems to give better results when constipation is a prominent symptom. It is a bland solution, however, and soothing the irritated condition. A weak alum solution, ʒss–ʒi alum to the quart, is of service where there is a generally relaxed condition of the mucous membrane of the rectum, with irritability of the sphincter, and tenesmus and frequent small movements. Such is found at times associated with a true catarrhal colitis (not dysentery) with a tendency to occur about bedtime and up to midnight. We do not confound this with a morning diarrhea.

Some prefer solutions B or C, 2 quarts, cold, at 70 to 90° F. daily. If necessary 6 ounces to half a pint or a pint are allowed to flow in before the outflow is allowed to occur. The best position is dorsal, with the hips elevated. Sim's position is at times employed.

2. Catarrhal appendicitis.—We believe catarrhal colitis to be a much more frequent cause of this class of cases than is generally supposed; also that many of the so-called rheumatic cases, benefited by the salicylates, salol, etc., are due to a colitis, and the improvement is due to iutestinal antisepsis.

We advocate daily irrigations, preferably with normal saline solution, and apply the bag, and give fluid diet, salol, etc. Solutions A, B, C, D, or E, 2 to 4 quarts once or twice a day are recommended. Cleansing the large intestine is a rational method if gas or fecal accumulation cause pressure on the inflamed part. Mechanically, any pressure or tension on the mesentery of the appendix interferes with its nutrition which is poor at the best. The element of self-infection from the absorption of accumulated feces should also be considered.

3. Membranous (Croupous) Colitis, such as following typhoid fever, etc. (see *Medical Record*, December 7, 1895).—Solution G, once a day, 2 quarts at 101° F. for three days. Result excellent. Solutions A, B, C, D at 101–105° F. can be employed once or twice a day until return is clear; or solution E or F at 101° F. once or twice a day—2 quarts. Same position, etc., as catarrhal colitis.

In the case referred to with solution G, the old model tube was used, but the new model has replaced it. Dr. Delafield employs solution G in these cases with the new 5-inch tube. Dr. William H. Thomson uses solution C.

4. Acute Dysentery. — Tenesmus, hemorrhage, etc., prominent symptoms. Solution A, B, C, or D once or twice a day at 101–105° F., until return is clear. Some use it also after each movement in addition. Solutions E and F, 2 quarts once or twice a day at 101° F. suggested; or solution G 2 quarts daily at 101° F., in severe cases for three days and then followed by milder solutions for several days.

In cases where there is considerable hemorrhage

employ several quarts of very hot solution, 110–120° F., or cold at 70–90° F., or at a lower temperature, care being taken to avoid shock. Some irrigate with 2 per cent tannin solution, or with 1 to 1,000 quinine in amebic cases. Solutions A and C have been favorably reported. Solution A by Dr. Delafield; solution C by Dr. Thomson.

5. Chronic Dysentery.—Solution A, B, C, or D daily, once or twice or more, 2 quarts or more; temperature, 101–105° F. Solutions E or F, 2 quarts once or twice a day, suggested at 101–105 F.

Very hot or cold irrigation if hemorrhage is severe can be used. Solution A by Dr. Delafield; solution C by Dr. Thomson.

6. Intestinal Dyspepsia.—Solution B or D 2 quarts once or twice a day at 101–105° F to wash out undigested products, or solution A, C, or E, if much fermentation.

In spasmodic colic due to gas accumulation Dr. Dessau advises its use in infants and children; a very hot saline enteroclysis at 110–120° F. for ten to fifteen minutes.

8. Chronic Constipation.—Solution B or D. (1) Hot douche, 102–120° F., 2 to 4 quarts once or twice a day, rectal or high irrigation, or, (2) cold douche, same method. Temperature from 80° F. to iced water, avoiding shock; or (3) alternate, two quarts, of hot and cold, at above temperatures once or twice a day. In this the glass Y is attached and the injector should be intermittent.

9. Intestinal Paralysis.—Solution A., B. or D.,

continuous irrigation at 110 to 120° F. for a considerable period, half an hour or even an hour (see Dr. Hyde's article, page).

Drs. Thomson and Grandin have secured excellent results from this method.

Solution A. would suggest itself as being excellent to promote peristalsis. About a pint to a quart of fluid should be kept continuously in the bowel.

FIG. XXXV.

Enteroclysis of Infant Double-Current.

10. Fecal Impaction.—Solution B. or D., at 101–105° F., continuous irrigation. Fecal accumulation has been washed piecemeal from the sigmoid flexure when enemata failed to act.

11. Gastro-enteritis in Infants and Children.–Solution B., daily once or twice until return is clean, at 101–104° F., employed successfully. See Fig. 35.

Solutions A., C. or D., at 101–104° F. daily, once or more are suggested; or Solution E., two quarts daily, at 101–104° F.

It might be employed cold at 80–90 F. in asthenic cases to reduce temperature, as Dr. Chapin advocates. It should be used thus with caution.

In cholera morbus, cholera infantum, or in fact any diarrheas where the lesions are in the small intestines, enteroclysis of the large intestine for cleanliness, and to prevent self-infection is logical. Same solutions as in class 11 above.

Also in cholera, irrigate with Solution B., at 102–105° F., or better at 110–120° F. as a stimulant. The 1 to 2 per cent. tannin solution is excellent. The irrigation with saline solution would be of service to dilute the poison, and aid elimination through the kidneys, on the same principle as hypodermoclysis for this purpose. It also replaces the loss of fluid from the body by absorption of the saline from the intestine.

In the same way it would be of value in severe cholera infantum.

12. Typhoid Fever.—Solution B., once or a twice a day two quarts or more, at 104–110° F., to cleanse the large intestine, relieve tympanites, and prevent self-infection. Irrigation can be continued from result excellent. Used when indicated. Solution A., C. or D., suggested in the same manner; or solution E. or F. daily, two quarts, at 102–104° F., suggested once or twice; or solution G., two quarts daily, at 102–105° F., for three days, then milder solution for three days, and so on, suggested in severe cases. The higher temperatures 108–110°, 115–120° act as a better diuretic and so favor elimination. When no

renal complications, an average temperature of 108° F. is excellent.

Irrigation daily with normal saline solution, morning and night in typhoid fever is an excellent procedure. After the foul products have been washed out, the effect on the kidneys is of value, as renal secretion is thereby increased and the elimination of the poisons of the diseases is thus aided. Cantani and others have advocated large enemata of cold water in typoid for the cleansing effect, and also the cold enamata to increase renal secretion, and reduce temperature. We believe cold water to be dangerous if there is any renal complication. Many patients have an idiosyncrasy to cold, and it is often depressing. In typhoid gas accumulation causes alarming symptoms through interference by pressure with respiration and the circulation, and also causing tenderness. Enteroclysis will relieve this.

Thus Dr. Thomson reports cases in the *New York Medical News*, Dec. 17, 1898, in which he employed saline enteroclysis in typhoid fever at Roosevelt Hospital. Many of these came from Moutauk Point. A check, other cases were treated without enteroclysis. Irrigation increased the action of the kidneys and favored elimination, and the patients in whom it was employed, ran a milder course of the disease though it was not apparently shortened. The tympanites was greatly relieved. He advocates saline enteroclysis in typhoid fever, as a routine treatment, believing it aids elimination of the poisons, through its diuretic action. He employs it whether the kidneys are affected or not. If the urine is insufficient or going on to suppression, the temperature of the enteroclysis should be 115–120° F., a pint to a quart being kept in the bowel continuously and the irriga-

tion prolonged from half to even one hour. Dr. Thomson advocates enteroclysis in an article published in the *New York Medical Record*, November 17, 1899, entitled "Ten Years' Experience with Typhoid Fever at the Roosevelt Hospital," read before the New York State Medical Association.

Note.—Continuous enteroclysis should not be employed when hemorrhages are occurring on account of causing peristalsis. Hypodermoclysis is of value at this stage as will be demonstrated later. We advocate in typoid fever. (1) To aid elimination of the poison by free diuresis. (2) As a stimulant to the circulation and respiration. (3) It cleanses the large intestine and prevents auto-infection from absorption. (4) It aids to empty the small intestine. (5) By removing the poisonous products from the large intestines, it diminishes the chance of a septic complicating colitis. (6) It relieves tympanties. (7) By the double method the operator does the work, and the patient does not strain, and is not exhausted.

13. During renal or biliary colic, enteroclysis at 102–105° to relax spasm and aid in passage of calculus, if gravel is impacted in the ureters employ normal saline solution, O1–1 qt.–1½ qts. being kept continuously in the bowel. Occasionally higher temperatures, 110–120°, seem to act better.

14. Tympanites—Enteroclysis at 102–105° F., though 110–115–120° F. often give better results, causing more active peristalsis.

The quantity of fluid injected continuously depends on the location of the tympanites. If there be a sausage-shaped protrusion parallel to the ribs,

or causing pressure on the lungs and heart, the large intestines, especially the transverse colon, are chiefly affected, and the quantity injected may be moderate, Oss–O1–1 quart kept continuously in the bowel.

If the protrusion be located chiefly in the middle of abdomen, the small intestine is most affected and more fluid must be injected, and Oss–Ojss–1 or 1½ quarts should be kept continuously in the bowel.

The patient, when there is much distension, often cannot void a simple enema with gas pressure behind it. Irrigation must often be continued from half to one hour, and gentle massage of the colon in suitable cases (not in typhoid) may be employed. The dorsal position without the bed pan is the best.

Position on the side often causes severe pain, due to torsion of the intestine and the efforts to expel as by obstruction. We have noted such in typhoid as case causing alarm.

15. Shock.—Solution B or D (B is the best). Normal saline solution at 110–120° F., preferably the latter, and the irrigation continued for a considerable period of time. We have seen it employed with success for forty miuutes to an hour continuously. The advantages are that a definite temperature can be kept up, and the quantity in the bowel can be estimated by having a containing vessel of definite measure and measuring the return, allowing for absorption. About one to two pints to one and a half quarts should be kept continuously in the intestine. This method can be employed during the operation.

It is of value to "prevent shock" and during chloroform anesthesia to prevent the sudden dilatation of the vessels. It should be employed in "shock

from hemorrhage, normal saline at 120° F., one pint to a quart or one and a half quarts kept continuously in the bowel should be used (see experiments).

Dr. R. H. M. Dawbarn employs this method after operation. He has enteroclysis at 120° F. given an hour on continuously with normal salt solution and then an hour off—often for twenty-four hours. The foot of the bed should be elevated. The Dorsal Position without the Bed Pan should be employed.

NOTE.—We have noted in commencing shock on the operating table an instantaneous improvement in the pulse immediately after starting enteroclysis at 120° F. with normal salt solution, and that too before infusion could be performed. This effect is shown in our tracings, page 11.

We advocate this simple measure to stimulate and, so to speak, "hold the patient" while the infusion is being performed. It acts by causing general vascular contraction and stimulation of the heart and respiration; it increases the body and blood temperature and helps fill the vessels through absorption.

In "Post-Operative Thirst" employ enteroclysis at 105°–110° F. with normal saline solution, one pint to one quart being kept continuously in the bowels.

16. Uræmia (suppression of urine or insufficiency with symptoms progressing in that direction) or simple insufficiency of urine.—Solution B. or D. (B. is the best). The temperature of the normal salt solution should be at 110°–120° F. Continuous irrigation for a considerable period, as in shock, from half an hour to even an hour. As much as twenty gallons have been employed; from a pint to a quart

should be kept continuously in the bowels, and this can be regulated by pinching the outflow tube and regulating the inflow, and also watching the quantity of the fluid in the fountain syringe. Dr. Thomson has employed it successfully and also advised its use in cases of uræmic suppression, when drugs, baths, cathartics, etc., had failed, the kidneys resuming their normal functions, also proper bowel and skin action resulting. Dr. Egbert H. Grandin employs this method in similar cases. In the *Medical Record*, December 7, 1895, a case of uræmia is reported treated as above. The high temperature (110°–120° F.) of the normal saline solution is most efficacious. In all cases reported we employed the *five*-inch rectal tube.

If it is desired to increase renal secretion without increasing pulse tension or temperature, irrigate at 100°–104° F., and at 105°–108° F. if moderate increase is not objectionable.

Irrigation with normal saline solution, in cases of acute suppression of urine, can be carried on for one half to one hour continuously, and every three hours if necessary. About half a pint to a pint or a pint and a half to a quart can be kept in the bowels continuously.

In renal insufficiency, irrigate at 102°–106°–108° F. for five to twenty minutes morning and night, or even at 110°–120° F.

In regard to renal insufficiency, we note an interesting case of Dr. William H. Thomson's. Woman, aet 58; passing on an average of ℥xii of urine daily, with resulting double pleurisy with effusion, due to the oliguria. Interference with respiration was so marked that the dorsal position was impossible. Diuretics, cathartics and diaphoretics had been em-

ployed without effect as a last resort. Before aspirating, an infusion of digitalis ℥ss t. i. d. was given, and a saline enteroclysis at 108° F. A. M. and P. M. for ten to fifteen minutes. The quantity of urine increased to ℥xl in twenty-four hours. After two days the enteroclysis was stopped, but the digitalis was continued. The quantity of urine immediately dropped to ℥xii. Enteroclysis was begun, and again the quantity was increased to ℥xl. The digitalis was stopped and the enteroclysis continued. Secretion of urine kept at ℥xl and increased to ℥L and in three weeks the effusion on both sides disappeared.

A second example, a patient of Dr. Malcolm Goodridge, Jr. Woman, aet. 26. Pleurisy with effusion, due to oliguria, 18–20℥ daily, aspiration, 14℥ removed; in five days a second aspiration necessary; though diuretics had been employed; 12℥ removed at this time. Enteroclysis at 120° for fifteen to twenty minutes then given A. M. and P. M., and also two hypodermoclyses ℥vi each, twenty hours apart. Urine rapidly increased to ℥xl daily, and finally to lx℥. The cavity remained empty and the patient went on to uneventful recovery.

The irrigation also serves to dilute the poison of the disease, and as shown the kidneys are practically washed out thereby. Elimination is aided by diuresis, bowel action and sweating which result. Foster also shows that, even when the nerve supply to the kidney is cut off, a saline solution, if injected, causes increased diuresis, it having evidently a specific action in producing renal secretion, exclusive of the vaso-motor influence.

Now physiological experiments and their clinical application do not always agree. In the deductions

as to temperature, it will be noted that irrigation at 110°–120° F. was recommended when the pulse tension or temperature was not high, since such temperatures increase the temperature and pulse tension. The effects produced by the irrigation modify these results.

Thus we have seen in acute uræmic suppression, with considerable pulse tension and a temperature of 102° F., from a twenty-minute irrigation at 110°–115° F., profuse diuresis, sweating and bowel action, and as a sequel a fall of pulse tension and temperature.

Dr. Simon Baruch has had a similar experience, as noted in his latest edition of "Hydrotherapy." If the vessels are atheromatous, too great a degree of heat might possibly be undesirable. Nitroglycerin, however, gr. 1/100 can be given by hypodermic injection to overcome this tension.

Cold irrigation we believe to be absolutely contraindicated in renal disease—also cold enemata.

In *pulmonary œdema* due to Oliguria.—Enteroclysis with normal saline solution at 110°–120° F. for fifteen minutes to an hour A. M. and P. M., according to indication.

If the patient cannot lie down—on account of Respiratory Difficulty—the semi-oblique posture, as in Fig. 31, can be employed, with the head, shoulders and chest elevated, so that the breathing is comfortable; the patient lying on his side, preferably the left, semi-obliquely, with the buttocks close to, or better, projecting slightly over the edge of the bed. The irrigator is passed through a perineal pad of gauze, or gauze and cotton, covered with oiled silk or oiled cloth, or even a dress shield. The arrange-

ment of the irrigator and foot-tub have previously been described.

Before, during, or after operation, a hot saline enteroclysis, or enema, can be given, if renal complications are feared.

17. In *Septic Conditions Irrigation with hot normal saline solution is of value to aid elimination of the poisons.* Thus in Diphtheria, especially where there is a marked sepsis, rapid and feeble heart, glandular enlargement, etc., even if the kidneys be not involved, enteroclysis with a normal saline solution at 110°–120° F. for fifteen minutes to half an hour to an hour, a half pint to a quart being kept in the bowels continuously, acts as a cardiac and respiratory stimulant, and aids to eliminate the poison through its diuretic effect on the kidneys. The irrigation can be given according to indication, every two or three hours if necessary, and preferably on the rubber sheet, without the bed-pan. See Fig. 34.

In *Diphtheria*, where there is albuminuria, or renal insufficiency, or a tendency to suppression of urine, irrigation at 110°–120° F. with normal saline solution, from half an hour to an hour, is invaluable. In this case a half pint to even a quart of fluid should be kept in the bowel continuously. We have recently advocated this method, in conjunction with hypodermoclysis, to be employed four to six hours subsequently to antitoxin injection. At this time they do not eliminate the antitoxin before its effects are secured, and yet they relieve renal congestion and aid elimination of the toxins.

In the "Transactions of the Association of American Physicians," vol. xiii, 1898, an article appears by Dr. William H. Thomson and myself, entitled "A

Case of Chronic Infective Endocarditis with Strep tococci in the Blood before Death Treated with Antistreptococcus Serum, and Experiments on the Effects of Injections of Serums and of Antitoxins on the Kidneys." We noted that large injections of Antistreptococcus Serum, or even of Normal Horse Serum, though the latter to a less degree, caused changes in the renal circulation and secretion and marked albuminuria, and pathological examination showed congestion of the kidneys. The antitoxin and serum were given in very large doses, in proportion to the size of the animal. The same quantity of the serum, or antitoxin, but given in distributed doses, over a longer interval of time, caused much less renal disturbance and less congestion.

On the other hand, in a dog infected for us by Dr. Park, and cured by the serum, the antistreptococcus serum, in destroying the poison of the infection (the streptococci), evidently lost its noxious qualities, since we found the circulation and renal secretion normal, and only a faint trace of albumen.

The following experiments have a decided bearing on the value of enteroclysis and hypodermoclysis in diphtheria:

Healthy rabbits were injected daily for several days with a definite amount of antistreptococcus serum and others with plain horse serum, the quantities being rather large in proportion to the size of the animals. They were killed by a sudden blow at the base of the skull, and the kidneys were examined macroscopically and microscopically, and all were somewhat congested; those in which the normal serum had been injected to a less degree than the ones in which antistreptococcus serum had been employed. Other healthy rabbits were injected in

the same way with the same quantity of serum, but these injections were followed by a hypodermoclysis of normal saline solution of twice the amount of serum injected. The animals were killed by the same method, and the kidneys were found to be much less congested than those in which the serums alone had been injected. In fact, the renal congestion was very slight. As we expected, the saline hypodermoclysis evidently eliminated the noxious qualities of the serums almost entirely. We advocate, therefore, the employment of enteroclysis and hypodermoclysis combined, three or four hours after the administration of the antitoxin, or even enteroclysis alone. See under Hypodermoclysis, with report of a case.*

NOTE.—Tracings of experiments with antistreptococcus serum will be found in Therapeutic addenda, under "Antistreptococcus Serum."

(*b*) *Other Septic Conditions.*

In the paper entitled "A Case of Infective Endocarditis", etc., the value of hot saline enemata and enteroclysis to aid renal elimination and remove the toxins was noted. Dr. Thomson employs enteroclysis in Typhoid for this purpose—see "Typhoid Fever." In Dr. Hyde's paper, "Rectal Irrigation in Gynecology," enteroclysis at 115° F. with normal saline solution was employed with success in commencing septic peritonitis following operation.

18. In *Malaria*, to "break the chill."

Enteroclysis at 110°–120° F. with normal saline solution, a pint to a quart, kept in the bowels con-

*Reported in a paper read before the New York Academy of Medicine, entitled "Treatment of Scarlatinal Nephritis," April 3, 1900; see also Pediatrics, Oct. 1, 1900, and following.

tinuously fifteen to thirty minutes. It might also be employed to "abort the chill," being administered just before it is expected. This suggested itself to us since both these effects were obtained in the case of Septic Endocarditis, to which we have alluded.

19. Jaundice (Duodenal).—Solution B. or D., two to four quarts or more once or twice a day at 101°–104° F. Others do better at 60°–80° F. Results excellent. Solution C. or B. suggested if there is much intestinal fermentation.

Some cases do better with extreme heat, 110°–120° F., or cold 60° iced water (36°–37° C.), or with the alternate hot and cold douche.

During the passage of biliary calculi hot enteroclysis at 110°–120° F. helps their passage and lessens spasmodic pain; the same is true in renal colic.

Most cases stand the hot irrigation best, and, given in somewhat intermittent fashion, it seems to give best results.

20. In Gynæcology.—In many conditions heat or cold can be applied to the uterus and its appendages better per rectum than per vaginam, as can be seen from observation of the anatomy of the parts; also in single women the advantages are self evident.

Temperature.—High temperature, 110°–120° F., as a rule, gives the best results in these cases. A lower temperature, 102°–105° F., is best during menstruation, if the flow is insufficient, as extreme heat might check it.

Position of the Patient.—Dorsal, or Sims, or Dorsal Position without the Bed-Pan.

Quantity.—From four or six ounces or a pint to a quart continuously in the bowel.

(*a*) Ovarian Neuralgia: Solution B. or D., daily rectal irrigation once or twice at 103°–105° F., two to four quarts in all. Position dorsal and level, two-thirds length of tube inserted. Vaginal douches and local applications had failed. Result excellent. A temperature even to 110°–120° F. can be used in some cases. Every case should be treated on its merits and individual idiosyncrasy observed. A few ounces should be kept in the bowel continuously, even to a pint or a quart.

(*b*) Pelvic Peritonitis: Solution A. at 120° F., one hour three times a day for ten days. The uterus, ovaries, etc., were agglutinated into a large mass. Patient irrigated in Sim's position. Result excellent —a nearly complete absorption of inflammatory products. This case due to the courtesy of Dr. Egbert H. Grandin. About a pint to a pint and a half should be kept in the bowel continuously. In general, the temperature employed is 104°–108° F. In many cases, as in the one cited, a temperature of 110°–120° F. *gives the best result.* Position, dorsal or Sims. In every case common sense and the individual susceptibility of the patient are to be considered. Solution A. is probably the best to promote absorption. Solution B. or D. can be employed (1) during menstruation, when insufficient (by Dr. Grandin), (2) dysmenorrhœa, (3) menorrhagia, (4) hæmorrhage, (5) inflammatory conditions of the uterus and annexa, etc. In *severe sepsis*, irrigation is of value both as a stimulant and to aid elimination. Employ saline at 110°–120° F., also in shock, intestinal paralysis, etc.

Thus, solutions A., B. or D., according to the case. Temperature 102°–104° F. average, or hot (110°–120° F.). Temperature 80°–90° F. average, (very cold or iced water, as in hemorrhage); care must be exercised if cold is employed.

During menstruation, if insufficient, use warm solutions, 101°–104° F., to promote the flow.

If *hemorrhage*, irrigate at 110°–120°, or cold, even to iced water.

If amennorrhœa, then employ heat at 110°–120° to induce a flow. Stop when it begins.

As a valuable contribution to the employment of Enteroclysis in Gynæcology we insert here the greater portion of a paper by Dr. Clarence Reginald Hyde, of Brooklyn, entitled "Rectal Irrigation in Gynæcology." This paper was read before the "Woman's Hospital Society," New York, May 16, 1899, and appeared in *The American Gynæcological and Obstetrical Journal*, August, 1899. He states as follows:

"The theory of rectal irrigation in itself admits of no new view, but its recent employment by specialists marks a distinct advance in routine methods, and furnishes a valuable acquisition to local therapeutic and mechanical measures in gynæcological practice, both before and after operative procedures. No apparatus yet devised for this specific purpose so scientifically meets the requirements as Kemp's tube, introduced to the profession some two years ago. Rectal irrigation will never supersede vaginal douching, nor is it intended to. Its advocates advance no such claim. But as a substitute in selective cases, it is sure to occupy a prominent position in our modern armamentarium. The ideas herein advanced are not to be conceived as an

attempt to advocate the superiority of rectal over vaginal irrigation, but to demonstrate that in certain types of ailments the former does surpass the latter.

"It is interesting to note in what manner rectal irrigation effects its particular action. When we recall how clearly defined the uterus and its appendages appear during a bimanual rectal examination, and how intimately the genital and rectal circulations anastomose, a clearer conception is gained of the more constringing effect of a prolonged rectal over vaginal irrigation. By the ballooning of the entire rectum with the hot fluid, a larger vascular area is directly presented to the heated medium, and its ultimate effect on the vessels is greatly increased. In vaginal douching, the introduction of the tube is necessarily limited by the vaginal vault, which allows the fluid to come into contact only with the vaginal walls and the portio, and affording no such excellent opportunity to be brought into almost immediate proximity to adnexa and the whole posterior surface of the corpus uteri, as in rectal. This statement will readily be acknowledged by all familiar with pelvic anatomy. Clearly, then, rectal irrigation permits these viscera and their abundant vascular supply indirectly to be more fully bathed by the hot water than in vaginal. In addition, by its retroactive effect on the intestines themselves, there is promoted through the sympathetic system, a stimulation of the unstriped muscular fibers in their walls, which not only increases peristaltic action, but seems to act reflexly even on the cardiac muscle, as noted in the use of this form of irrigation in counteracting shock. This fact is noticeably apparent by a comparison of the quality and tension of the pulse before and after irrigation. Part of this

cardiac stimulation may be due to absorption of the saline and its filling of the vessels. The heart thus receives more fluid, and necessarily its action must be spurred on in its endeavors to compensate for this increased fluid. The employment of rectal irrigation is not the administration of an enema, and in private practice it is policy to make this point clear to the patient at the outset.

"One expert in the use of rectal irrigation can employ it without even soiling the bed's or the patient's linen, but at first trial it is advisable to spread a rubber sheet under the hips or use the dosal position with patient on a douche-pan. The vesical tenesmus, which at times supervenes, seems best relieved by suppositories of iodoform, conium, and belladonna, which also tend to quiet any rectal irritation which may persist.

"As to the cases in which rectal irrigation is applicable, considerable limitation is allowable. Experience and judgment are the criterion, when to use or not. At least two gallons—preferably six to eight gallons of water at 110°–115° F. give the best results.

"In virgins with rigid hymen or small introitus, who present one of those typical histories of leucorrhœa following a prior and, perhaps, obscure attack of localized peritonitis (due either to a previous exanthematous attack, bathing or other exposure during menses, with succeeding temporary suppression), when the effect of a vaginal douche is required, rectal irrigation is *par excellence* the ideal method of depleting the pelvic circulation. Especially is this true in the leucorrhœas of retroversions or other displacements, and in ovarian congestions. Rectal irrigation not only acts as an efficient

substitute, but it obviates any relaxation of the hymen, and also precludes the enervating effect of a prolonged hot douche in a young unmarried female. A large quantity of water is necessary to produce the desired vascular constriction, and a small quantity will not exert such a benefit. It is also a well-known fact that prolonged douching lessens the normal vaginal acidity, which is Nature's barrier to the entrance of pathogenic organisms, with the possible exception of the gonococcus of Neisser and the bacillus tuberculosis. To this end have the lactic-acid douches been recently advocated by Ilkewitsch and Dalché. Advocates of rectal irrigation can advance a step further, avoiding vaginal douches entirely in young, unmarried girls, and yet accomplishing the same ultimate effect.

"The following cases are narrated as examples of the efficacy of rectal irrigation.

"Mrs. C., æt. 40; vaginal hysterectomy, with considerable hæmorrhage and shock succeeding operation, followed two days later with complete intestinal paralysis and evidence of sepsis. Extreme tympanites, pulse 160, weak and wiry, temperature 104.2°, and patient rapidly becoming moribund. Repeated enemas and free use of cathartics of no avail. Prognosis grave and recovery regarded doubtful. To my knowledge rectal irrigation had never been employed previously in any such case in this hospital. Six gallons given, 115° F. The intestines, which before had refused to react to any stimulation and expel their contents and gas, now feebly responded after the second gallon, and strongly during the remainder of the irrigation. Large quantities of gas were voided, the patient became less restless, and the temperature and pulse fell per-

ceptibly in a short period of time. Her condition was almost immediately improved, and she made an uneventful recovery. The irrigation was continued at intervals for the following few days. It was the general consensus of opinion that there had been a localized septic peritonitis, sufficient to induce intestinal paralysis. Certainly the outcome was nothing short of remarkable.

"Mrs. M., æt. 33, panhysterectomy. Severe hæmorrhage during the operation compelled the use of a large number of clamps, which were undoubtedly the origin of the infection which later supervened. The patient's condition was almost identical with that of the first. After removal of the clamps in thirty hours, rectal irrigation proved successful in warding off the development of an undoubted fulminating septic peritonitis.

"Its value is again forcibly demonstrated in shock following operation, using normal saline as the agent. I speak now of shock accompanying severe major operations, with no evidence of hæmorrhage. Dr. Hanks strongly advises this, and reports excellent results. Even in secondary hæmorrhage, after the bleeding point has been secured, its efficacy cannot be denied. Under such conditions and cognizant of the absorptive power of the rectum so far as saline is concerned, we note in addition to increase of bodily fluids, a secondary stimulating effect on the heart, as previously mentioned.

"Every gynæcologist has had the irritating experience of post-operative patients complaining of pelvic distress, dull and aching in character, or annoyed by the slight tympanites which occasions the convalescent so much discomfort. The use of

rectal irrigation in such conditions will produce in the patient a fuller sense of relief and more permanent in action than any known drug or form of enema. This can be well illustrated in a recent abdominal section in which this pelvic distress yielded quickly to the use of the Kemp tube. The annoying sequelæ obtaining during the first few days disappear readily under this form of irrigation. An interesting private case of intestinal colic is recalled, supposedly due to the presence of adhesions, with unremitting nausea, pain, and restlessness. All the much-lauded specifics absolutely failed, and enemas resulted negatively. Rectal irrigation afforded most marked relief, controlling the nausea and decreasing the pain as to occasion patient little suffering. The prevalence of chronic constipation in the majority of women is so common as to call for more than routine methods. The latest addition to our array of remedies seems to be rectal irrigation, through the complete stimulation of the entire lower alimentary tract, and the subsequent addition of tone to its mucosa. My own experience, in private, includes one case, a distinct failure. She conscientiously employed it nearly two months, about three quarts of saline every night. The constipation disappeared in the interim, but returned on discarding the irrigation. Her condition at present is as formerly.

"One other failure is to be noted. Mrs. R., æt. 18; acute gonorrhœal pyosalpinx, acute septic endometritis, double pyosalpinx, and punctuated at short intervals with three successive attacks of localized peritonitis within the space of seventeen days. Ice bags and rectal irrigation were ordered. The irrigation produced no results and was ill-tolerated, the patient complaining of severe pain during its admin-

istration, vesical tenesmus, and a constant desire to evacuate the bowels at intervals afterwards, with futile results. Its failure was a distinct surprise. The deduction may be assumed that rectal irrigation is not the ideal remedy in acute suppurative processes, but rather is its field in acute and chronic catarrhal inflammations and congestions, which it relieves through depletion of the intimate vascular anastomosis with the rectal vessels.

"To epitomize. Rectal irrigation has been found to have a distinct value in

"1. Leucorrhæas.

"2. As a substitute for vaginal douching in young girls.

"3. Acute and chronic ovarian and tubal lesions, with the possible exception of pyosalpinx.

"4. Intestinal paralysis, following sepsis.

"5. After major pelvic operations to relieve any abdominal discomfort or tympanites.

"6. Intestinal colic.

"7. Doubtful in constipation.

"Rectal irrigation commends itself to gynæcologists for thoughtful and unprejudiced consideration, as having seldom failed to meet the test on fair trial."

This paper of Dr. Hyde should be of especial interest to the general practitioner as well as to the gynæcologist. In reference to it, however, we will state that we have seen good results in some cases of pelvic peritonitis of the acute suppurative type, but we are inclined to think the procedure should be tried on more cases of this character before coming to a final determination. There are often idiosyncrasies in patients, and a poor tolerance of enteroclysis for any purpose whatever. We have also noted

that in some cases of retroversion the pressure of the fluid on the pelvic organs has caused nausea and discomfort.

Noting the failure in the case of a patient with chronic constipation, we may state that we have seen both failures and successes in this obstinate condition, but the method is worthy of trial. We would suggest that if the continuous hot douche fails, a short enteroclysis with cold water, 80°–90° F. at first and cautiously employed, can be tried, or the short, alternate hot and cold douche, with the glass Y-attachment, as suggested by Dr. J. C. Minor. His method has been previously described.

We would call to the attention of our reader that the dorsal position without the bed-pan best favors the escape of gas—the Sim's posture, or even the slightly strained posture on the bed-pan causing interference and producing torsion in the gut and pain in expulsion of the gas.

21. Rectum.—*Position of the Patient:* Patient may be sitting upright on the closet, or semi-obliquely, or lie in the dorsal, or Sims position, with the shoulders higher than hips. Lying on the side (especially the left), with the buttocks projecting slightly over the edge of the bed, is a convenient posture. There should be a rubber sheet beneath the patient, arranged to carry the fluid in to a foot-tub.

A temperature of 110°–120° F. generally gives the best results in rectal cases. A low temperature, 60° F. to even iced water (36°–37° F.), sometimes are employed.

Quantity.—From four ounces to half a pint to a pint and a half should be kept in the bowel con-

tinuously, depending on the nature of the case. Prolonged irrigation gives the best results. It has been employed in the following conditions:

(*a*) Congestive condition of the rectum, with ulcers following operation for hæmorrhoids. (See *Medical Record*, December 7, 1895, cases of Dr. Charles T. Parker.) The result was excellent. Cold irrigation was administered for forty-five minutes morning and night.

Solution B. or D. can be employed either cold or hot, as 60°–80° F., or even iced water, or 108°–120° F., morning and night, depending on the patient, and from ten to forty-five minutes; four ounces to the pint of it kept in rectum continuously, depending on the case; or Solution E. or F., two to four quarts morning and night, hot or cold, as above, if such disinfection is necessary.

Some cases do better with hot, some with cold. *Extreme degrees of either seem to be most satisfactory;* heat from 110°–120° F. gives the best result as a rule, and the irrigation should be prolonged, even to thirty or forty minutes.

(*b*) Proctatitis, ulcers, fissures, etc. (four ounces to half a pint to a pint and a half should be kept in the bowel continuously). Solution A., B., C. or D., two to four quarts once or twice a day at 101°–104° F. suggested. Solution E. or F., two quarts daily at 101°–104° F. Solution G. suggested every few days, two quarts at 101° F. in syphilitic ulcers; milder solutions during interim.

I have recently employed Solution A. with success in a slight ulcer. Some cases do better with cold solutions at 60°–90° F., or even employing iced

water. If there is hæmorrhage from the ulcers, employ extreme cold or extreme heat, and an alum solution, ℥i alum to quart of water, or even stronger if necessary, etc. Other solutions for above conditions will suggest themselves.

(*c*) Internal hæmorrhoids (four ounces to half a pint should be kept in the bowel continuously): Solution B. or D., two to four quarts or more at 102°–104° F., or even to 120° F., once or twice a day; or cold, 60°–80° F., or even iced water.

Some do better with one, some with the other. We have employed both as a temporary palliative, and with considerable relief. The flexible tube, infant size, is the least painful in these cases. Extremes of heat or cold seem to be the best. This same method is suggested in the endeavor to attempt to abort ischio-rectal abscess; also irrigation of the rectum in "inoperative" cancer cases, for cleanliness, disinfection, etc.

(*d*) Fæcal Impaction: Solution B. or D. employed at 101° F. by continuous irrigation, until the hard mass is washed out piecemeal.

22. Genito-urinary.—In most of these cases a few ounces (from two to six to half a pint to a pint) kept in the bowel continuously are sufficient.

Position.—Patient sitting upright, or semi-oblique, or on the side, with shoulders higher than the hips.

In self-irrigation of the prostate we have found the following method convenient: Hang the fountain syringe about a foot above the level of the patient's head and on the left side; attach the tube of the fountain syringe to the central tube and

an inch of soft tubing to the curved tube of the irrigator. Insert the irrigator about one-third to half its length, the curved tube looking toward the perinæum. The central tube of the irrigator passes between the middle and ring fingers of the left hand; the index and middle fingers support the curved tube of the irrigator. (See illustration Fig. 35). The

FIG. XXXV.

Self-irrigation of the Prostate per Rectum.

patient leans somewhat forward, as if to have a movement. The wrist is supported by the left buttock. The index or middle fingers respectively regulate the inflow and outflow by bending a kink in the soft tubes. The clip is thus unnecessary.

NOTE.—We have found the posture on the right or left side, with the shoulders elevated, to be excel-

lent when an attendant performs the irrigatio
Prolonged irrigation is necessary in all these case

Temperature.—High temperature of the flui
110°–120° F., and prolonged even from one-half-t
one hour, generally gives the best results. This ca
be employed in some cases morning and nigh
or even more frequently. At times cold irrigatio
40° F., or iced water (36°–37° F.) and prolong
gives better results; or the alternate douche (
and cold).

NOTE.—More patients have an idiosyncrasy
cold; heat is generally better borne.

NOTE.—Renal disease with polyuria as a sympt
would seem to contraindicate this method, or th
should be cautiously used and for short peri
This statement has special reference to a
of enlarged prostate, in which prolonged irriga
was employed. It aggravated the polyuria and
to be stopped. Continuous enteroclysis has
employed with success in the following condit
of the Prostate Gland: (1st) Congestion, (2d)
inflammation, (3d) chronic enlargement, (4th)
tatorrhœa.

"*Prostate.*" (1) Congestion: Solution B. or D.
quarts or more, even up to thirty or forty min
irrigation, at temperature 60°–80° F., or even
water, or 104°–120 F. The normal saline soluti
the best to employ.

We have employed cold with excellent res
some cases do better with heat. Prolonged ir
tion seems to give the best results—in some
even to an hour.

(2) Acute Inflammation: Solution B. or D., as above suggested, hot or cold, or Solution A. at 104°-120° F., from fifteen minutes to an hour, once or twice a day, to promote absorption.

NOTE.—A temperature of 110°–120° F. and prolonged irrigation even to an hour gives the best results.

(3) Chronic Enlargement: Solution B. or D., from fifteen minutes to an hour, once or twice a day, at 104°–120° F., has relieved radically many of the symptoms, such as urinary irritability, tenesmus, etc.; or Solution A. by the same method and temperature has been suggested as capable of promoting absorption.

The use of the small, repeated enemata is somewhat irritating at times to the patient, and the temperature cannot be kept even or the act prolonged. In many cases of chronic enlargement heat is an important factor in the treatment, and this enables us to employ it continually for the prostate. It seems worthy of trial. The instruments for the application of dry heat are of necessity of small calibre and not far reaching.

Some cases might do better with cold, 60°–80° F., or even iced water, or with the alternate hot and cold douche. The use of heat at 104°–120° F. and prolonged seems, however, to be the most logical. The soft-rubber tube with metal center can be employed if desirable to secure a curve, or the short, flexible tube. Personally, we have had the best results with heat as great as could be borne, 110°–120° F. and prolonged from thirty to forty minutes, or even an hour morning and night. We have generally been able to use the hard rubber tube with

satisfaction, or the new model (hard-rubber with metal center). The metal irrigator is also excellent. If the metal tube is employed, it should be protected at the region of the sphincter by surrounding it with a small piece of soft rubber drainage tube, as the metal is a marked conductor of heat.

Dr. Robert W. Taylor, in his recent work on "Sexual Disorders of the Male and Female," advises it even at 125° F. in a certain class of cases in combination with massage of the prostate, and also the seminal vesiculitis; and Dr. Raynor Hayden employs it in these cases. Dr. L. Bolton Bangs advises its use in cases of retention of urine when the prostate is much congested. Dr. Taylor has found it of service in cases of retention, to relax spasm, and enable catheterization to be employed.

(4) Prostatorrhœa: Solution B. or D., two to four quarts or more once or twice a day. 1. Hot—102°–104° F., even to 120° F., once or twice a day for half an hour. 2. Cold—60°–80° F., or even iced water. Short period to even half an hour once or twice a day. (3) Alternate douche (hot and cold)—once or twice a day from ten to twenty minutes with Y-attachment, as suggested by Dr. Minor. The average case probably stands heat better than cold.

(*b*) Seminal Vesicles.—Inflammation: Solution A. suggested, two to six quarts once or twice a day, or even to half an hour or an hour, at 105°–120° F., to aid absorption; or Solution B. or D. suggested. 1. Hot—two to six quarts or more once or twice a day at 105°–120° F. even to half an hour or more. 2. Cold—60°–80° F., or even iced water, to half an hour once or twice a day. 3. Alternate douche (hot

and cold)—once or twice a day with Y-attachment. A temperature of the normal saline solution of 110°–120° F. and prolonged to half an hour to even an hour twice daily gives the best results.

Heat, as a rule, is better borne. The other methods are worthy of trial.

In Conditions of the bladder: (1) Acute cystitis, (2) chronic cystitis, (3) tubercular cystitis, (4) nocturnal irritability, (5) incontinence of urine, (6) retention of urine.

(1) Acute Cystitis: Solution A., temperature 105°-120° F., once or more a day, from five to forty-five minutes, suggested. Higher degree of heat seems the best. Solution B. or D. the same.

Cold irrigation has recently been reported as affording considerable relief in a case in which there was evidently tendency to abscess formation (peri-urethral) at neck of bladder. As the case became subacute it was changed to hot irrigation. This case was reported to me by Dr. William H. Thomson, as seen in consultation. The temperature of the patient, 104°–105° F., was reduced by irrigation.

Solutions B. or D., at 60°–80° F., five to thirty minutes once or more daily, might be used as above mentioned in certain cases, or even iced water.

Heat at 110° to 120° F., as a rule, is better borne and relieves bladder irritability.

(2) Chronic cystitis, (3) tubercular cystitis, (4) nocturnal irritability: Same irrigation, A., B. or D., hot, as above, to relieve bladder irritability. In this class I have found the best results from irrigation at a high temperature, 110°–120° F., and prolonged to forty minutes.

Occasionally cold irrigation, 60°–80° F., or even iced water or the alternate douche, does better.

(5) Incontinence of Urine: Solution A., a temperature 104°–120° F., once a day or oftener and from five to forty minutes, is suggested, or Solution B. or D. 1. Hot—104°–120° F., five to forty minutes, once or more a day. 2. Cold—iced water to 80° F., fifteen to twenty minutes, once or more a day. 3. Alternate douche (hot and cold)—Y-attachment, two to six quarts, once or twice a day.

NOTE.—The high temperatures, 110°–120° F. and prolonged, give as a rule the best results.

The alternate douche is suggested by Dr. John Minor. Thus, he reports, in a case of "locomotor ataxia" the incontinence was greatly relieved, and reflexly the gait improved, by use of the alternate douche. Other regulation remedies had been employed—strychnine, spinal douche, electricity, hot rectal douche, cold rectal douche, etc.

(6) Retention of Urine: Solution B. or D., irrigation at 110°–120° F., to relax spasm and aid urination or the passage of the catheter, for five to thirty minutes or an hour, has been of benefit.

Higher degrees of heat seem the best (110°–120° F. and prolonged even to an hour).

19. *Penis* (*A*).—Diminution, or loss of erectile power. Solution B. or D. 1. Hot—105°–120° F., five to thirty minutes or an hour once or twice a day. 2. Cold—Iced water to 80° F., the same. 3. Alternate hot and cold douche, two to six quarts each in divided quantity, six ounces to a pint or quart, once

NOTE—Dr. Robert W. Taylor in "Sexual Disorders of the Male and Female" recommends this method.

or twice a day. Cold douche should be used cautiously, as many have an idiosyncrasy to cold.

NOTE.—The hot enteroclysis with normal saline solution at 110°–120° F. and prolonged for an hour morning and night often gives excellent results. The alternate douche especially has been of benefit.

B. Chronic Urethritis (gleet); especially deep-seated, as in the prostatic urethra.—Continuous rectal enteroclysis with normal saline solution at 110°–120° F. for an hour A. M. and P. M. is often of value in these cases by causing constriction of the vessels supplying the parts. The same has been noted in gonorrhœa with complicating epididymitis, or acute orchitis.

The heat, by constricting the blood vessels, diminishes inflammation and seems thus to lessen the nutrition of the specific poison. It acts as does rectal irrigation in leucorrhœa, as described in Dr. Hyde's article, "Rectal Irrigation in Gynecology." About six ounces to a pint should be kept continuously in the bowel.

23. Nervous Conditions.—1. Some cases of melancholia, etc., are judged to be due in part to absorption of poisons from undigested food, etc. Solution B. or D., daily irrigation at 101° F. once or twice. Two quarts or more to prevent self-infection. Solution C. or E. the same, if there is much fermentation. Two quarts once or twice a day.

(2) The possibility of influencing the circulation, secretions, and nervous system through the abdominal plexuses, would suggest itself. Solution B. or D. thus by the (1) Hot douche—101°–120° F. (2) Cold douche, 80°–90° to even iced water. Also (3) alternate douches (hot and cold) are worthy of

experiment; (see "effect on gait in a case of locomotor ataxia," mentioned under incontinence of urine.)

When the rectum is irritable we generally inject half an ounce of salt solution, and in it an eighth to a quarter of a grain of cocaine, before inserting the rectal tube.*

Solution B. (normal salt solution) is physiologically superior to Solution D.

24. Enteroclysis may further be of value in poisoning to aid elimination of belladonna, etc., also in any condition of circulatory failure. Its further indications not herein noted, will be found under the indi. cations for Hypodermoclysis and Infusion.

We believe that by the double-current method, by position and irrigating gently, small amounts of fluid will do the cleansing required, as on the principle of washing the stomach or bladder. We do not advocate great distention of the gut under any circumstances. The caput coli and the colon are a "sink for refuse," so to speak, and in diarrhœas of the small intestine there would certainly be a tendency for accumulations below and from them more or less septic absorption. The good results obtained by intestinal irrigation seem to be the clearing out of such products. We question if sufficient fluid ever passes the ileo-cæcal valve to be of practical benefit above that point. Some, however, hold this view.

We believe that cleanliness of the large intestine may often prevent or mitigate many complications. By this we do not mean that the rest of the intesti-

* NOTE—Emptying the rectum previous to enteroclysis by a small enema is often of service.

nal tract should be neglected. The close relation of the large plexuses to the intestines, and the influence on the system through them, are also worthy of note.

In concluding this portion of our Manual we wish to state that we do not advocate "Enteroclysis" as a "cure all," but that we employ it, as an adjunct to other methods of treatment. In many cases it is only a palliative, and at times, like any other therapeutic agent, it will prove a failure. Idiosyncrasies exist, and with some it cannot be used at all. Our only plea is that it should be given a fair trial, not in one case, but in many; and, being given such, we believe it will be found to be of value.

In the succeeding chapter, we will describe some "Special Methods of Treatment" devised by Dr. Fenton B. Türck, of Chicago.

CHAPTER VII.

DR. TURCK'S SPECIAL METHODS OF TREATMENT OF DISEASES OF THE INTESTINE.

Treatment of Sigmoid and Colon by Direct Methods.

We quote from Dr. Türck as follows:

"In the treatment of the colon direct methods may be employed. The most common pathological condition is chronic colitis simplex, chronic membranous colitis, associated with symptoms of diarrhœa and constipation. The colon may become dilated, and generally the transverse colon. With prolapse, the sigmoid is frequently found dilated, with elongated meso-colon. In the treatment of the stomach and colon it will be found that the intestines are also affected, especially by some of the following methods: First, by the introduction of ice water with massage of the colon; second, by the method of irrigation by the use of the needle douche, with alternating hot and cold water; third, by the use of the hot-water bag, with double tube within the stomach, or colon; fourth, by application of oil of cloves and cinnamon through a double tube with a nebulizer; fifth, by the use of the gyromele.

Ice water is introduced into the colon through a single tube. The patient is placed with the hips elevated. Then it is massaged downward until it reaches the cæcum. When it has reached the cæcum the hips are lowered and it is massaged out through the rectal tube, and runs into a receptacle placed be-

neath the operating table. The amount of water introduced each time is from four hundred to six hundred cubic centimetres. This alternating injection and expulsion is continued until three or four liters have been used. The introduction of ice water stimulates the congested vessels to a marked degree. No chilling or depressing effects are produced, as when ice water is applied externally. The peristaltic action is also increased. It does not remove the secretions of the colon to the same extent as warm water. Secretions are essential for lubricating and facilitating the passage of fæcal matter through the colon. Warm water is a vaso-dilator, and when rectal injections are taken in the usual manner harm

FIG. XXXVI.

Needle Douche.

results, producing weakness and inducing the injection habit and increasing the symptoms of constipation. In the ice-water treatment with massage, pressure should be exerted on the abdomen with the patient's knees flexed. It is necessary to use both hands, the left hand placed over the right, and pressure should be gradually exerted, until it is made directly on the colon and its contents. Rubbing the abdominal wall in the usual manner is not colonic massage.

The Use of the Double-Tube Needle Douche for the Sigmoid.—The stomach needle douche, which was presented by me at the "American Medical Association," May, 1895, I have used for a long time in the treatment of the colon. It consists of two single

tubes of different calibre arranged side by side, the large tube projecting beyond the smaller tube. At the end of the smaller tube is attached a small, perforated bulb for producing a shower. The smaller tube is made with perforations along its side and over the blind extremity. The water is forced into the smaller tube under pressure by the compressed-air irrigator. The effect is to produce a fine shower or needle douche, hence its name.* (See Fig. 36.)

The effect of the fine shower against the walls of the intestine is that of a vasomotor and muscular stimulant, similar to that produced by a rain douche on the surface of the body. Where the sigmoid and lower colon become markedly dilated and atony is present, with congestion of the vessels, the use of alternating hot and cold water by the needle douche is of great value.

This apparatus was reported at the "American Medical Association," May, 1895, and also before the "New York Academy of Medicine." The first paper was published in the *Journal of the American Medical Association*, May, 1895, and the second in the *American Medico-Surgical Bulletin*, July 1, 1895.

In general it is not necessary to use a force pump to compress the air, but I have simply used a small rubber bulb, similar to that used with an atomizer. When hot and cold water are used alternately, two irrigators are necessary. The irrigators are made in the usual way. A bottle, through the cork of which a glass tube passes, is connected with a rubber bulb. By compression of this, the air is compressed over the water on the bottle. This forces the water out of the bottle into the irrigating tube. Thus

* Einhorn, Edson and others have devised stomach sprays much the same.

a shower is produced under pressure by compressing a single bulb. By using a glass Y-tube, connected by a single bulb attached to the stem of the Y, the ends of the glass tube being attached to the rubber tube, which again leads to each bottle—namely, the hot and cold water—the air is compressed into both bottles. The outflow tubes from the irrigators are connected with another glass Y-tube, the stem of the Y-tube being connected with a single rubber tube. Hot and cold water can be used alternately, by having a simple cut-off snap on the tube leading from each bottle. This simple device is within the reach of all. A mechanical stimulation is produced by the impact of the small, needle-like streams emanating from the perforated tube, and the circulation of the whole pelvis is affected and the tone increased.

The introduction of water directly into the colon, or stomach, has for its objects cleansing and stimulation of the viscera. If the temperature is not sufficiently high, the water acts as a vaso-dilator and rather increases than reduces the congestion. To overcome these obstacles, I have devised a rubber bag (see *Journal of the American Medical Association*, January 11, 1896) with a double-tube attachment, which is introduced into the colon or stomach, or both. One side of the double tube is connected with a hot-water irrigator at a temperature ranging from 120°–130° F. Water is passed into the rubber bag and out through the other tube into a graduated bottle. The amount and temperature of the water passing into the bag may be regulated at will. The bag, when collapsed, fits around the tube and does not materially enlarge it. Its distention is limited for use in the colon to about three to three inches and a half in diameter. (See Fig. 37.)

The temperature-regulating mechanism is very active internally, as well as externally. This must be recognized in my direct internal methods of treatment—namely, the use of a constant flow of water at high temperatures through a rubber bag in direct contact with the viscera. The action of this high temperature direct upon the vessels within the viscera is prompt, resulting in marked vasomotor stimulation.

The surface of the body under treatment by this method shows a glow; a sensation of warmth follows as the circulation becomes equalized in the reduction of the visceral congestion, and the hands

FIG. XXXVII.

and feet become warm. The good effects are lasting. I find it of use not only in intestinal diseases, but also in cases of shock, marked by internal congestion, and have introduced this method during operation, where shock is imminent. In use in the colon, the pelvic viscera are affected, and its value in dysmenorrhœa due to congestion, or anæmia, is apparent. The time of each treatment is twenty minutes, to half an hour. It is then siphoned, or aspirated from the bag, and the latter withdrawn.

Use of the Nebulizer with Double Tube.—This apparatus was first described and shown before the "American Medical Associasion," May, 1895, in which attention was called to the use of nebulized oil of cloves and cinnamon and other oils for

the treatment of the walls of the stomach. I have discovered that the introduction of air with the nebulized oil of cloves and the resulting contraction forcing the air out of the stomach produces a pneumatic gymnastics, giving strength and tone to the weakened muscles of the stomach.

FIG. XXXVIII

Nebulizer.

I used this method of treatment in diseases of the colon, especially when it is dilated, with a lack of peristaltic movement. I also use this, for diagnostic purposes, in both the stomach and colon, as the degree of distensibility and expulsive force can be readily determined. The double tube is passed through the rectum into the sigmoid, the nebulized oil of cloves and cinnamon passes upward, and, as the colon becomes distended, the air forced into the colon carries with it a cloud of essential

oils, reaching the cæcum. The cloud of oils forms a thin coating on the mucous membrane, and this thin coating remains for a long period of time. (See Fig. 38.

Experiments were performed illustrating the value of the nebulized oil of cloves and cinnamon in preventing or retarding the development of micro-organisms, as with mixed cultures of colon bacilli and staphylococci.* They did not, however, destroy the colonies already formed. The essential oils named are also vasomotor stimulants. This is illustrated by a simple experiment. If a cloud of pure oil of cloves and cinnamon is allowed to play on the end of the tongue, it will be seen that the papillæ soon become injected and of a bright-red color, simulating in appearance the so-called "strawberry" tongue. These oils are also powerful analgesics, as the tongue in this experiment loses for the time being its sensitiveness to pain. For their antiseptic, analgesic, and vasomotor stimulating effects they have long been empirically used for toothache.

It is not alone for the local effect upon the mucous membrane that this double-tube nebulizer is so valuable, but its effect is that of a pneumatic exerciser. As the air with the cloud of oils passes through one side of the double tube, partially distending the colon, the pressure of the contracting organs forces the air out through the other side of the double tube. In cases where there is a marked distensibility, where the colon lacks resistance, the muscles soon gain tone or strength; under this method of alternating expansion and contraction a compensatory hypertrophy results, and the normal

* Space precludes a description of the experiments, but a full report can be obtained in the journals already noted.

peristaltic movements are restored. These oils, therefore, act as antiseptic agents and vasomotor stimulants, overcoming the congestion found in these cases, and, in combination with the pneumatic gymnastics, provide a simple and effective method of treatment of the colon.

The Gyromele.—The use of the gyromele has proved to be of great value in the diagnosis and treatment of diseases of the stomach. The instrument as it now is meets with success at the hands of the general profession. However, I have made improvements that in some cases are of advantage.

Instead of drawing the tube to and fro to reach the different parts of the stomach, the tube in the improved gyromele remains stationery. The tube passes through a small rubber button, or spool, which the patient holds between the teeth, while the cable slides backward and forward to reach the desired area.

The cable is covered with a soft, close-fitting rubber tube, which makes it entirely smooth. The covered cable revolves within the outer stomach tube.

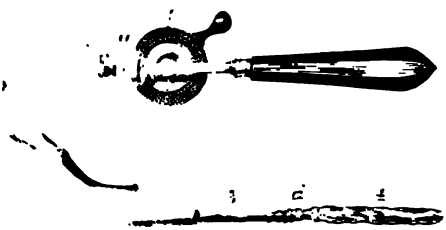
The sponge covers a spiral. The end of the spiral fits into a socket securely and tightly. It may be detached with ease when so desired.

The revolving apparatus has been made to run noiselessly, with perfect smoothness and evenness. The wheel is of metal (thin plate), covered on one side by unpolished soft rubber. This rotates against a smaller rubber wheel, causing no noise whatever. (Fig. 39.)

The new gyromele consists of four parts:

No. 1. Revolving apparatus.

No. 2. Stationery outer tubes.



... gyromele, is its
... be seen and
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... suffi-
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In cases of membranous colitis, atony of the colon, or dilatation of the sigmoid, with symptoms of constipation, the gyromele has been found to be of great value. The instrument was described and shown by me at the "International Medical Congress," Rome, 1894, and was first used in gastric diseases in the treatment of inflammation (chronic), with symptoms of myasthenia (muscular weakness).

Method of Use: The sponge is passed through the rectum up to the sigmoid, and rapid revolutions are produced. In some cases, I have been able to pass through the sigmoid into the colon, which was demonstrated by palpation of the revolving sponge upon the abdominal wall.

When a stiff sound is used, there is great danger of puncturing the sigmoid, as the sound pushes against it, forming a pocket. A flexible tube simply curves upon itself and rolls up within the rectum, or sigmoid. A stiff tube, curved in the shape of the sigmoid flexure, has also been tried. This also fails, as the curve of the sigmoid varies, and the meso-sigmoid varies in length, giving great mobility to the sigmoid flexure. Kelly's long, straight speculum has been used with some success, but it is difficult to determine whether the curvature of the sigmoid has not been pouched and pushed upward, instead of entering the descending colon. Where there is an elongated meso-sigmoid, the flexure can be pushed as high as the splenic flexure of the colon.

The revolving sponge of the gyromele seeks the point of least resistance. It sometimes finds a curve of the flexure, and glides up and around through the curvature, into the descending colon. This can be done by simply pushing up the flexible cable, as this would act in the same manner as the flexible rectal

tube does. It is a matter of chance that the revolving sponge in its rapid revolutions insinuates itself, so to speak, through the narrow entrance leading from the sigmoid into the descending colon.

The principal value of the gyromele in the colon is:

1. Removal of adherent material, such as scybalæ, It is effectual in membranous colitis, used with liquid soap. Liquid soap helps to loosen the glue-like substances. The agitation caused by the rotary movement, together with the effect of winding off the adherent material from the walls, cleanses the surface. The loose material can thus be easily removed by the use of the double-tube douche, used with the pneumatic-force irrigator.

2. In the colon it has a similar mechanical effect as in the treatment of stomach diseases. It is especially valuable in dilatation, with myasthenia or "muscle weakness." The vibratory effect of the revolving sponge and cable, shows itself in increasing peristaltic movements of the intestines. It can be felt upon the abdominal wall, and in thin subjects the vibratory waves can be readlly observed.

Since vibratory movements have been shown to have a marked effect upon the circulation, stimulating the dormant muscle cells into activity, and thus aiding cellular nutrition, this treatment has been recognized as a method of considerable value, and is especially valuable in dilatation and atony of the sigmoid.

3. When it is desired to apply medicaments by topical application, they can be injected through an

opening made for that purpose at the upper end of the gyromele. Antiseptics, astringents, or medicaments may be used in any menstrum, thick or thin, as deemed best.

4. The gyromele has also been employed to give electrical treatment. One is introduced into the colon, another into the stomach, and the faradic, galvanic or sinuscidal current employed. The latter is said to produce painless contractions."

Regarding the methods described by Dr. Türck we have had no practical experience, and report them as a novel technique, and one which may prove to be of interest.

The stimulating effect of the dry heat with the rectal bag would necessarily be excellent in shock, but there would be no absorption of fluid to help fill the vessels, and the possibility of damage from the rubber to the mucous membrane of the bowel would suggest itself.

The extent to which the flexible gyromele would be under control of the operator is a question to us, and also the results to be secured by the spray. Having had no experience with these methods of treatment, we leave it to the experience of others.

The colonic massage and other methods appeal to us, and we believe that it is by original investigation, such as Dr. Türck has performed, we secure "progress" in the Science of Medicine.

In the following chapter we shall describe the Application of Dry Heat or Cold in the Rectum.

CHAPTER VIII.

THE APPLICATION OF DRY HEAT OR COLD IN THE RECTUM.

Though not included in Enteroclysis, this topic should be treated under the subject, "Intestinal Hydrotherapy."

Dry Heat or Cold may be employed in the Rectum for:

a. Prostatic Inflammation.
b. Inflammation of the Seminal Vesicles.
c. Internal Hæmorrhoids.
d. Irritable Bladder, etc.

The following is a list of instruments used for this purpose:

1. Condom, with two tubes or catheters.
2. Arzherger's Cooler, straight or curved.
3. Wiener's Cooler.
4. Goldenberg's Instrument.
5. Guiteras' Rectal Bag.
6. Türck's Water Bag for the Rectum or Sigmoid.
7. Kemp's Prostatic Cooler.
8. Kemp's Ice Tube for Hæmorrhoids.
9. Kemp's Soft-Rubber Rectal Bag.

The oldest method is the employment of a condom with two tubes, or catheters, tied in; one for the inflow and one for the outflow.

Arzberger's coolers, straight or curved, are the first instruments invented for the above purposes. They are readily understood from the plates (Figs. 40 and 41). They are rather large and somewhat painful

to introduce. There is a tube for the inflow and outflow. A combined dilator and cooler (Fig. 42) is also shown—Wiener's instrument (see Figs. 43 and

FIG. XL.

Arzburger's Straight.,

44). It is much thinner where it passes through the sphincter, and is expanded at the prostatic end with

FIG. XLI.

Ahzburger's Curved.

a depression on its upper surface. The instrument is divided internally by a septum, nearly its entire

FIG. XLII.

Dilator and Cooler Combined.

length, the water passing along one side of this and then down the other side, and out into a receiving vessel.

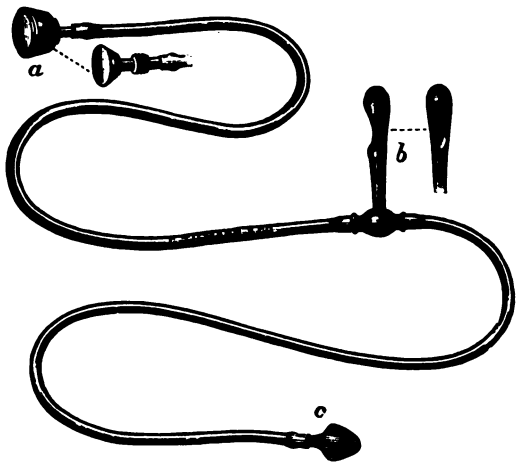
Goldenberg's instrument is practically Wiener's, with a long handle, with perineal curve (Fig. 45.)

FIG. XLIII.

Wiener's.

Guiteras has a soft-rubber rectal bag with a Y attachment to regulate the inflow and outflow.

FIG. XLIV.



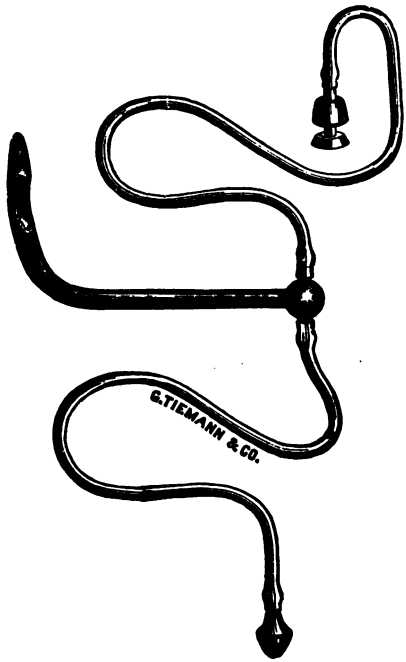
Wiener's.

Our prostatic cooler will now be described, also the ice tube for hæmorrhoids and the soft-rubber rectal bag.

NOTE.—Türck's instrument is described in the preceding chapter, pages 133 and 134, Fig. 37.

A Prostatic Cooler aud a Glass or Metal Tube for the Application of Ice to Hæmorrhoids.—The pros-

FIG. XLV.



Goldenberg's.

tatic cooler, is a small, closed glass or metal tube about four inches long, rounded at its apex, and flattened just behind this, on its upper surface for about an inch. It is about one-fourth of an inch in diameter; larger sizes can be secured. It divides at

its outer extremity into a Y, as shown in the illustration (Fig. 46) The upper branch of this is twice the diameter of the lower, and to it is attached the tube of a fountain syringe. The lower branch is about half the diameter of the upper. This serves for attachment of a small soft-rubber carry-off tube. It keeps full since the entering current, is twice the diameter of the outflow. The tube should be filled in the vertical position to expel the air. Before insertion, it should be nearly of the temperature of the fluid employed. This avoids danger of cracking the glass tube, if this be employed after in-

Kemp's Prostatic Cooler.

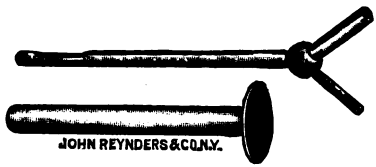


FIG. XLVI.

FIG. XLVII.

Kemp's Ice Tube for Hemorrhoids.

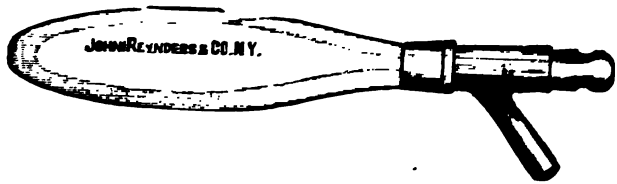
sertion; also of employing too high a temperature. The glass tubes have the advantage of being clean and cheap. A metal cooler is now manufactured, and is the better instrument.

If the clip is attached to the carry-off tube, the pressure from above might crack the glass tube. We have used them in acute congestion of the prostate, —cold water; chronic enlargement, irritable bladder, —hot water; relieving the congestion; also in internal hemorrhoids.

NOTE.—Similar tubes are made—diameter, one-half or five-eighths inch, but without the depression on the upper surface—for the application of heat or cold in the vagina.

The glass or metal ice tube for hemorrhoids (Fig. 47) is practically a test tube of thick glass four inches long, with a wide flange at its mouth to prevent it slipping into the bowel. It is to be filled about two-thirds with pulverized ice and salt, and a cork inserted. The glass tube should be tempered to the cold before inserting. The tubes are made in several sizes, the smallest one-quarter inch in diameter. The metal tube is preferable.

FIG. XLVIII.



Kemp's Soft-Rubber Rectal Bag.

A Soft-Rubber Water-Bag for Use in the Vagina or Rectum (*American Medico-Surgical Bulletin*, September 23, 1896).—The instrument consists of a cylindrical wire framework, four inches long and about the diameter of the little finger. This is covered by a soft-rubber bag about one inch in diameter, which can be folded about the central core. The core is to give sufficient stiffness to allow of the insertion into the rectum or vagina; the tip is protected so it cannot be pushed through the bag. The outer end of the bag has a metal cap, which divides into a Y—a longitudinal tube, the larger for the attachment of the tube of a fountain syringe, and the small, oblique tube for the outflow tube (Fig. 48). The rubber bag can be folded about the core, lubricated, and then inserted into the vagina

or rectum. The attachments having been made, the clip on the tube of the fountain syringe is opened and the bag will fill up, forming a soft pad about the core. The entering bag being twice the diameter of the return, the bag will keep full.

By this method heat or cold can be applied without wetting the patient. The apparatus can be easily carbolized. It can be used as a simple water-bag by filling it and corking the openings. The core can be made of a single piece of hard rubber, or metal if so desired. This would give more space for fluid.

Having completed the first division of our Manual, "Intestinal Hydrotherapy," we will enter upon the second topic, "Hypodermoclysis."

CHAPTER IX.

HYPODERMOCLYSIS.

Hypodermoclysis may be practically defined as the "Injection of Normal Saline Solution into the Subcutaneous Tissue (cellular)."

This valuable addition to our therapeutics was first brought into prominence during the cholera epidemic of 1892, so that the procedure is not a new one. Clinical application, as well as experimental research, have demonstrated its value in many other conditions.

The technique is simple and comparatively safe,—we say "comparatively," and some of our readers may question this statement, yet serious results have followed improper methods. A case was reported to us in which, as a result of hypodermoclysis beneath a woman's breasts, sloughing of such severity occurred that a complete amputation of these organs was rendered necessary. Evidently the injection had been given too rapidly, or in too large a quantity, with resulting interference with the circulation.

PRECAUTIONS.—Care must be observed that the fluid flows in slowly, so that the tissues be not overdistended, and that absorption may readily take place.

The fluid should flow from the needle at the moment of puncture,—also the fountain syringe should never be allowed to become completely emptied,—to avoid *entrance of air* into the tissues.

Dropsy Not a Contraindication.—Some authors state that dropsy,—or a dropsical condition of any of the organs, or serous cavities, as pulmonary œdema,—are absolute contraindication to a hypodermoclysis; for, if such exist, the patient would, so to speak, be "drowned out," if additional fluid were injected.

We trust such statements will not be accepted seriously. The ætiology is the guide; thus, if pulmonary œdema be due to oliguria, a hypodermoclysis of normal saline solution is of service—of moderate size, four to six ounces, and repeated. This seems more satisfactory than a single large injection. A hypodermoclysis enters more slowly into the circulation than an infusion, and the danger, to which some authors allude, of "overwhelming an overworked heart" is eliminated. It should not be injected into œdematous tissue. In pulmonary œdema, when there is a tumultuous heart, cyanosis, etc., a preliminary venesection is of value. Scarification, wet or dry cups, blisters, nitroglycerin, or amyl nitrite can be substituted if necessary.

We quote extensively from our article, entitled "Observations and Suggestions Concerning Hypodermoclysis," *New York Medical Record*, April 14, 1900:

Site for the Injection.—The Ilio-Lumbar Region for Hypodermoclysis: There have been numerous locations advocated for hypodermoclysis, as beneath the breast, in the chest, abdomen, thigh, axillary space, cellular tissue of the neck, back, etc. We would suggest a region that seems especially advantageous—the space between the highest part of the crest of the ilium and the lower border of the ribs—

in effect the loin, but rather the outer margin of the lumbar region, and which for convenience we have denominated "ilio-lumbar." It does not interfere with the dorsal posture, nor do movements of the limbs or neck, or the thoracic or abdominal respiration, cause discomfort. The illustration (Fig. 49), which was drawn from life by Mr. Thomas Nast, Jr., clearly demonstrates the method.

FIG. XLIX.

Hypodermoclysis in the Ilio-Lumbar Recion.—From the *New York Medical Record*, April 14, 1900.

We are aware that some inject antitoxin into this region, and also that the lumbar site has been employed for hypodermoclysis, but we believe the puncture to have been more dorsal in location.

Quantity of the Fluid in Hypodermoclysis.—The Rapidity of Absorption is Modified by Existing Clinical Conditions: We have already described the method by which we demonstrated that elimination by normal saline solution, given subcutaneously,

begins in three and one-half to four minutes after the injection has been made (see experiments, page 21). This, of course, is under normal conditions of the circulation.

Though hypodermoclysis under normal conditions is, in rapidity of entering the circulation, next to infusion itself, yet under certain other clinical conditions the absorption is much delayed, and for practical use it is actually the least rapid in its action of the three methods.

In uræmic conditions with a feeble circulation, or in shock, the absorption of the lymphatics wlll also be nearly at a standstill; even a small hypodermoclysis will be absorbed very slowly. A subcutaneous injection has a certain degree of tension to overcome (caused by the pressure of the fluid itself), and also does not possess the advantage of stimulating by its heat, since a high degree of heat would be harmful in circumscribed cellular tissue under high tension, especially with the blood supply enfeebled. On the other hand, a hot saline solution distributed over a large surface, as the peritoneum, or given by enteroclysis or enema, is an entirely different matter. There is here no resistant tension of high degree to be overcome; the fluid has a wide area of distribution for absorption, and, most important, there is an immediate reflex stimulation of the circulation itself from the heat, and hence in turn rapid lymphatic absorption.

In any condition in which the general circulation is markedly impaired, hypodermoclysis is naturally a slower method; nevertheless it is of great value, for we find that absorption can be hastened by the addition of enteroclysis at 110°–120° F. while performing the hypodermoclysis, or even by a simple

hot saline enema. We would advocate enteroclysis (continuous) at 110°–120° F. while giving the subcutaneous saline injection. Gentle peripheral massage during the injection also hastens absorption.

We shall mention a certain class of cases in which, though the rapidity of absorption is lessened, yet the results secured by hypodermoclysis would seem exactly to fulfill the indications. We refer to hemorrhage from typhoid, or gastric ulcers. In hemorrhage with moderate or even fairly severe collapse it is efficacious. It replaces the loss of blood, and also on account of entering the circulation indirectly through the lymphatic system, is not so likely to start up hemorrhage, by a sudden and marked stimulation, as is infusion. The saline solution is claimed by some to have certain "hæmostatic qualities." We have frequently noted in the Adirondacks that some advocate giving small amounts of salt water by mouth, in cases of pulmonary hemorrhage, claiming this effect. Saline solution thus administered we believe might be liable to cause vomiting and thus aggravate the bleeding, but we mention the claims set forth. Overstimulation after pulmonary hemorrhage, we have noted, however, with resulting secondary hemorrhage. We believe hypodermoclysis to be safe and often efficacious, stimulating, so to speak, to the "safety line." Dr. Thomson recently secured brilliant results in a case of hemorrhage from typhoid ulcer at Roosevelt Hospital, and we obtained an excellent result in a case of gastric ulcer with severe hemorrhage.

Hildebrand, of San Francisco, states that one dram of normal saline solution in proportion to the pound of body weight is the maximum quantity to be employed; thus, in a patient weighing 100

pounds, 100 drams or 12½ ounces will be taken care of by the kidneys every fifteen minutes.

Practically the necessity for such frequency of injection would never occur, though it shows with what rapidity the saline is eliminated by the kidneys. It is interesting to note that the maximum amount usually injected at one time is just about in the ratio stated.

Occasionally, however, a greater quantity may be given, as in Shock or Hemorrhage, in divided dose in two regions, thus causing less pain and giving us better absorption. The age of the patient and condition for which it is employed all modify the quantity.

Our own experience teaches us that a hypodermoclysis in smaller amounts, and repeated several times if necessary, gives us better results than a single large quantity. There seems less strain on the kidneys and better elimination. As a general guide we may say that in adults—in Uræmia, Diphtheria, etc.—we have employed on the average normal saline solution four to six to eight ounces subcutaneously, at a single injection, at one site, and repeated if necessary in another region in ten to twelve hours, and once or twice more in that time if required. This is only a general guide, and we will refer again to the matter in "Indications for Hypodermoclysis."

Solution to be Employed in Hypodermoclysis.—The ideal solution is normal saline (or more strictly speaking decinormal saline solution), or 0.6 per cent. solution of salt water—roughly speaking, a dram of table salt to the pint of water, boiled and filtered.

NOTE.—Some employ a 0.6 per cent. of saline solution +0.1 to 1.0 per thousand of thymol (Dr. Von Heinleth); or 0.6 per cent. of saline solution +1 per thousand of peroxide of hydrogen (Prof. Rumpf); 1 to 2 liters (1¾–2½ pints) were injected at a time in cholera.

In asthenia Chéron injects every two to three days five to ten grains of a solution containing carbolic, sulphate and phosphate of soda and sodium chloride; and others a two per cent. neutral phosphate of soda solution.

Sodium chloride, 5 grammes; sod. sulphate, 10 grammes; water distilled, 1 liter.—Hayem's artificial serum.

Matthieu states that if glycerin or carbolic acid be added to the solution the *pain is not so severe*, and that no accidents appear to have followed their use, not even cellulitis. Carbolic is nevertheless, as we all know, irritating to the kidneys, and this danger is evident. We believe there is absolutely no advantage in these modifications and that they tend to *irritate* the kidneys.

Technique of Hypodermoclysis.

Antisepsis.—The region selected for the injection —preferably the Ilio-Lumbar—should be thoroughly cleansed with soap and water, then with alcohol, and afterward with bichloride of mercury 1/1000, or carbolic solution (one per cent. to three per cent.) if the bichloride be not at hand. The site of injection also better be shaved.

The hands of the operator should be thoroughly scrubbed with soap and nail brush, the nails cleaned,

and the hands disinfected in antiseptic solution—bichloride or carbolic.

Instruments should be Sterile.—A Davidson's syringe, glass irrigating jar, a funnel or fountain syringe can be employed. Kelly suggests the reversed aspirator. We prefer the fountain syringe.

The fountain syringe and tube should be sterile—boiled in water for one-half to one hour—and also the needle for hypodermoclysis. An aspirating needle of moderate size is convenient, since the longer needle can be inserted a further distance; also the flow is more free, and it is not as readily stopped.

The *larger the needle* the more care must be exercised as to regulating the quantity and the rapidity of the flow by pinching the inflow tube; also the fountain syringe should be hung above the patient—lower, if a large needle is used, as the height influences the pressure. A larger quantity of saline should be placed in the bag than is to be injected, so no air can be sucked in, and the solution should flow from the needle while making the puncture.

The average height of the fountain syringe, an aspirating needle being employed, is from two to three feet, depending on the rapidity of the flow. There is less distension and pain and better absorption when the bag is hung low.

In emergency an ordinary hypodermic needle may be used. In this event, before attaching it, the solution should flow from the tube, to evacuate all air, and the needle then tied in, the tube pinched at the end. Otherwise air passes so slowly through the fine needle that time is lost.

The patent fountain syringe, which can be in-

verted without spilling, is useless for this purpose, we have found by actual experience; the absence of air pressure at the opening, though only slight in amount, prevents the flow through the small needle. It acts, apparently, as when the finger is placed over the filling aperture in the nasal douche and checks the flow. On the other hand, the slight difference in pressure from that in the old open syringe does not interfere with the flow through the larger enema tip, though, as stated, it does so with the fine needle.

With the small hypodermic needle the bag must be elevated four to six feet above the patient, as a

FIG. L.

rule, to overcome the resistance on account of the fine stream. A satisfactory hypodermoclysis can be given by this method.

The following is reported in the *New York Medical Record*, April 14, 1900:

"*A Simple Attachment Convertiug an Aspiratıng or a Hypodermic Needle into a Needle for Hypodermoclysis.*—This attachment consists merely of a small fitting (Fig. 50), with a screw thread of a size suitable to screw into the average aspirating or hypodermic needle. It has an enlargement adapted to fit snugly the rubber tube of a fountain syringe or Davidson's syringe. It is a simple and cheap device to save the trouble of tying into the tube the average needle, which is generally of small calibre,

even at its base. The attachment being metal can be boiled. An aspirating needle of convenient size for hypodermoclysis can be purchased with it if so desired.*

"The fluid should flow freely from the needle as the puncture is being made. If the flow ceases, on account of the resistance to the small stream, pushing the needle in and then withdrawing it slightly or rotating it will generally start it again. This cessation of the flow is generally due to the small point of exit becoming clogged by the cellular tissue, and these movements will free it."

The needle should be pushed in semi-obliquely and steadily, not suddenly plunged in; also care must be exercised, as regards not injuring the blood vessels or nerves, or forcing the needle in too deeply. Some push it deeply into the muscular tissue. This seems to us to result in the lumps in the tissues of which complaints are so often made.

We prefer to inject in the more superficial cellular tissue, allowing the fluid to enter slowly and aiding absorption by gentle peripheral massage. As the tissue fills up the direction of the needle can be changed carefully without withdrawing it, so that the injection can be made in the arc of about three-fourths of a circle.

Great caution should always be exercised so not to overdistend the tissues.

Fluid Employed.—Normal Saline Solution: One dram of salt to the pint of water, sterilized (boiled and strained).

* By attaching a small piece of rubber tubing we can connect this to a small-pointed glass syringe, or small rubber syringe, and improvise a cheap antitoxin syringe. The ordinary hypodermic needle can be employed and the quantity of antitoxin measured with the barrel of the hypodermic syringe.

Temperature of the Fluid.—There is a great loss of heat when the fine needle is employed, and the fluid in the fountain syringe should then be about 110° F. It will then reach the tissues at about the proper temperature. If the larger aspirating-needle is used, the fluid can be at 105° to 108° F.

We find that the solution after flowing through the tube and hypodermic needle loses 6°–8° of heat.

Quantity of the Fluid.—Four to eight ounces in average cases and repeated, depending on the conditions. In shock and hemorrhage, ten ounces to even a pint and a half, but preferably injected at several sites. Enteroclysis at 110°–120° F. with normal saline solution and continuous for one-half to one hour, during or directly after hypodermoclysis, is of great value in hastening absorption, and so enables us to employ more fluid by subcutaneous injection. It is preferable to begin enteroclysis while performing hypodermoclysis.

Anæsthesia (Local).—Employing ethyl chloride, or ether spray, freezing with ice, or touching the point to be punctured with a drop of carbolic acid. The latter can be neutralized with a few drops of alcohol or whisky. Ichthyol ointment also has an anæsthetic effect if applied some time previously. In a nervous patient local anæsthesia is preferable.

Dressing of the Puncture.—As the needle is removed, the finger should be slipped over the puncture to prevent the escape of fluid.

After drying off the moisture with aseptic gauze, or cotton, a small piece of sterilized or antiseptic gauze should be placed over the puncture, and over this a

single thickness of gauze, or a thin layer of absorbent cotton. Collodion (flexible) can be painted over it all, or a piece of adhesive plaster may be applied.

One dressing, as a rule, will be sufficient, and in twenty-four to forty-eight hours the puncture will be healed.

If the case be septic, or we desire to employ additional precautions, we can anoint the entire area of œdematous tissue, at the close of the operation, with five per cent. ichthyol ointment.

Indications for Hypodermoclysis.

The indications for this procedure can be readily deduced from a statement of the effects produced thereby.

1. It increases the quantity of fluid in the vessels by replacing that which has been lost, as from hemorrhage or diarrhœa; or by adding fluid to the circulation, and thereby acting as a *stimulant* to a rapid and feeble heart action. Thus, in "shock," it aids filling the vessels when general dilatation of them has occurred and the heart has insufficient fluid to work upon.

2. It dilutes the poison of disease and aids in elimination of the toxic products, through the diuretic action on the kidneys, as in septic conditions, uræmia, etc.

3. It causes profuse diuresis and relieves kidney congestion; thus, as in uræmia or renal insufficiency, or renal congestion, either primary or complicating any other disease. Even small quantities have a specific effect in the production of diuresis.

4. The saline injection is claimed by some to have a certain "hæmostatic effect" in hemorrhage, as from typhoid or gastric ulcer. The quantity for

this purpose would be moderate in amount (four to six ounces, and would not, like infusion, at once cause a marked pressure rise and increase the danger of hemorrhage. On the same principle we have seen small quantities of salt water given by mouth in pulmonary hemorrhage.

Thus, for example, Hypodermoclysis is of value—*in all Diarrhœas*—where there are profuse movements with a resulting great loss of fluid to the body; or a rapid and feeble heart, or a condition of sepsis from the toxic effects of the disease, whether these conditions exist alone or together.

Included in this list would be dysentery (acute and chronic), cholera, cholera infantum, cholera morbus, typhoid fever, and in all diseases of this character. The quantity to be employed depends on the severity of the case and the age of the patient.

In *gastro-enteritis in infants*, with numerous watery movements, hypodermoclysis is of great value. In a child weighing eight pounds we could infuse slowly one ounce of normal saline solution at a time. Occasionally two ounces in two regions might be necessary to be employed. There might be indications, however, under certain conditions to employ a greater quantity. Thus, in an infant in shock from hemorrhage, we could infuse several ounces slowly (two to eight ounces), the indication being to watch the pulse; for the same reason we might employ a somewhat larger amount in using hypodermoclysis.

Hypodermoclysis in entero-colitis in infants and children, etc., is of special value to replace the loss of fluid. The method has long been employed. Dr.

R. H. M. Dawbarn in 1892, we believe, was the first so to use it in this country.

We advocate moderate-sized injections, watching the effects and repeating several times if necessary. In adults four to eight ounces up to a pint of normal salt solution may be injected according to indications. It may be advisable to inject the smaller quantities several times, or the larger amount once or twice daily.

With infants, one or two ounces daily or twice a day.

NOTE.—Some advocate the use of sterile blood-serum and report good results; we believe too much strain is put upon the kidneys by its employment, as practically foreign material must be eliminated. Other modifications have been suggested, but we recommend normal saline solution as the best to be employed.

Hypodermoclysis in Dysentery or Cholera, etc.

Larger amounts may of course be indicated; thus, in cholera eight ounces to a pint and a half may be necessary at a time in one or several regions. Judgment must be exercised.

In *all septic conditions*, as in peritonitis, septicæmia, pyæmic conditions, in the toxic poisoning from diphtheria (scarlatina), cholera, typhus, typhoid, diabetes, etc., and in uræmic poisoning, hypodermoclysis acts to dilute the poison of the disease and eliminates the toxins through the kidney diuresis. The quantity to be employed depends on the clinical conditions. To quote:

"We would especially *call to the attention of our reader that a marked reaction frequently follows hypodermoclysis when administered in septic condi-*

tions; thus, there may be a well-marked rigor, like that of pneumonia, and the temperature may rise even to 105°–106°, the pulse may become more rapid and the respiration panting—in fact, the patient may appear worse for a short time. These symptoms have frequently caused alarm. They gradually improve, however; free diaphoresis sets in, the headache disappears, the temperature falls rapidly, often to normal, and a feeling of comfort supervenes. The emunctories are extremely active, and often there is a polyuria, occasionally a profuse diarrhœa.

"If improvement is only evanescent, a second hypodermoclysis should be administered."

Hypodermoclysis as an Eliminative in Diphtheria following Antitoxin Injection: Experimentally (see experiments) we find that if a serum injection is followed later by a normal saline hypodermoclysis, renal congestion is much lessened.

Hypodermoclysis should not immediately follow antitoxin injection, as it would probably eliminate the serum rapidly; if given three or four hours later, it would aid in the elimination of the toxic products of the diphtheria, and also in the removal of any toxic products of the serum if such existed, or if the patient should be especially susceptible.

It is of value also in the Toxæmia of Diphtheria, as an eliminative and as a circulatory stimulant. It has been suggested for the same reasons, as has infusion, that it be employed in Pneumonia, Septicæmia, Peritonitis, Pyelitis, Septic Endocarditis, Purpura Hemorrhagica, Burns, Toxæmia due to Colon Bacillus, Tetanus, Pyæmia from any cause, grave Jaundice, Plague, Yellow Fever, Scarlatina, Measles, Puerperal Eclampsia (preceded by venesection).

Hypodermoclysis in Kidney Affections—Primary, Secondary, or in Conditions Resulting from Oliguria, etc.:

In Uræmia, Renal Insufficiency, Renal Congestion, Suppression of Urine, etc., hypodermoclysis dilutes the poison, aids elimination through its diuretic action, relieves renal congestion, and is a powerful stimulant to the kidney secretion; thus, in suppression of urine or renal insufficiency, it is most efficacious.

In our experiments we demonstrated the specific effects in producing diuresis when normal saline solution was administered by hypodermoclysis.

We frequently find moderate quantities (four to six ounces repeated every three or four hours) seem to give better results than a large quantity given all at once. Also there is less strain on the kidneys.

Enteroclysis, combined with this method, is of value.

In the *Deutsches Archiv für klinische Medicin*, Lenhartz, in an article entitled "The Therapeutic Value of Saline Infusion in Acute Diseases," advocates frequently repeated injections, preferably subcutaneously and in moderate quantity, as promoting the excretion of injurious substances better than the employment of a very large volume of saline at each injection, given less frequently.

Elimination begins in three and one-half to four minutes, and the smaller quantities of saline would soon be cast off. The objection as to a large quantity being necessary and hence painful, thus "falls to the ground," since small amounts are generally more efficacious.

Hypodermoclysis in Oliguria.—Often oliguria is a symptom of commencing scarlatinal nephritis, and

in this the method is of value; two or six ounces may be employed and repeated if indicated.

Hypodermoclysis in Nephritis Complicating Diphtheria; Enteroclysis also of Value: In this condition we recently secured a brilliant result in a patient of Dr. Thomson. Renal complications appeared before antitoxin was administered—casts, albumin, a small amount of blood, and diminished secretion. Antitoxin (Board of Health), 4,500 units, was given: 1,500 the first dose, with no improvement; 3,000 five hours later. The renal condition persisting four hours after the second injection, a hypodermoclysis of ℥vi. of normal saline solution was given, followed at once by enteroclysis with normal saline solution at 115° F. for thirty minutes. Four hours later a second enteroclysis was given. The urine increased in quantity; in twenty-four hours only a few casts were found, and in forty-eight hours there was nothiug abnormal. This was most satisfactory.

The same method is of service in renal conditions, complicating any infectious disease.

Hypodermoclysis in Pulmonary Œdema.—This may be employed as an aid by its diuretic action, if renal insufficiency be an etiological factor.

Hypodermoclysis in Pleurisy with Effusion: We have found this of value in this condition, if insufficient diuresis is an etiological factor. In a case of this character it has recently been employed immediately following aspiration. It has been used with success, clearing up the effusion by its diuretic action and rendering aspiration unnecessary.

Hypodermoclysis could be employed in ascites or dropsy, due to oliguria, etc., but it should not be given in œdematous tissue.

Hypodermoclysis with Sodium Salicylate as a

Diuretic in Uræmia, etc.: Dr. S. J. Meltzer has reported a most interesting case—a patient of Dr. Robert Abbe, of this city. The patient was suffering from uræmic suppression, and Dr. Meltzer, having noted the diuretic effect of sodium salicylate in his experimental researches, employed it clinically and with excellent results.

NOTE.—Sodium salicylate is claimed by some, however, to aggravate renal congestion, if such exist.

Hypodermoclysis in Poisoning: This method would seem of value in cases of poisoning, especially by alkaloids, as it aids elimination through the kidneys, and stimulates the heart and respiration. In mushroom poisoning it has been employed successfully it is claimed. Infusion has also been used. In belladonna poisoning we would suggest its value. Since belladonna is markedly eliminated through the kidneys, hypodermoclysis in moderate amount and frequently repeated would be of service. Frequent catherization, of course, should be performed. In opium poising, or in poisoning from other causes, it is worthy of trial. Hypodermoclysis in arsenical poisoning, carbolic acid poisoning, also in alcoholism, alcohol poisoning, carbon monoxide poisoning, etc., is suggested, as is infusion.

Dr. H. C. Wood states that though after small doses of atropine the urine is said to be increased, and sometimes almost doubled in quantity, yet after large toxic doses it may first be increased, but is generally lessened early, and in the later stages may be entirely suppressed.

This is a further reason to hasten its elimination, and prevent its being locked up in the system by urinary suppression.

Hypodermoclysis might be employed in painters' colic, to eliminate the poison through the kidneys.

We believe, in our treatment of "Hypodermoclysis," that most of the indications for this procedure have been described. We have been rather minute in our details regarding operative technique, since upon them rest the success or failure of the measure. As an addition to our "Therapeutics," we deem it to be of the greatest value, and that it could be employed much more frequently by the general practitioner, with benefit to the patient. In the succeeding chapter the important topics "Infusion" and "Shock" will be discussed. The writer, Dr. R. H. M. Dawbarn, is well known, both for original experiments on "Infusion" and also for the practical application of the results that he secured. To his courtesy we owe this valuable addition to our manual.

INFUSION.

CHAPTER X.

INFUSION.

ALSO A "SPECIAL ARTICLE ON SHOCK AND ITS TREATMENT" AND "ANÆSTHESIA AND ITS RELATIONS TO SHOCK," BY ROBERT H. M. DAWBARN, M.D. SURGEON TO THE CITY HOSPITAL, PROFESSOR OF SURGERY IN THE NEW YORK POLYCLINIC MEDICAL SCHOOL AND HOSPITAL, ETC.

Infusion may be defined as the "Injection of an Artificial Serum, most frequently of a Decinormal Saline Solution, into the Vascular System." The term *Transfusion* is commonly understood to mean the introduction of defibrinated blood into the circulation.

Hypodermoclysis acts through lymphatic absorption, and should not be properly included under infusion, any more than should the enema. Some authors classify it under this heading, but incorrectly. The methods employed in Infusion are Intra-arterial and Intra-venous.

I. Intra-Arterial Infusion may be classified as follows:

1. For example, Division of the Radial Artery and the use of the Canula Directed Toward the Periphery.

2. Needling the Femoral Artery. (Dawbarn's Emergency Method.)

II. Intra-Venous Infusion may be classified as follows:

1. Injection into the Median-Basilic, Median-Cephalic, Internal Saphenous, or other prominent Superficial Vein; the Stream Directed Toward the Heart.

2. A Vein in the Operation-wound is Employed for the Infusion.

3. Needling a Superficial Vein with a Hypodermatic Needle. (Kemp).

INTRA-ARTERIAL INFUSION.—1. This method signifies the injection into an artery (preferably the radial as being superficial and easily felt at the wrist) of a normal saline solution. The stream is directed toward the periphery.

OPERATION: The arm is abducted from the side, the forearm supinated, and steadied upon the table by an assistant. It is well to scratch very lightly the cuticle, just where the pulse is most easily felt. The limb is now elevated and "milked," and the upper arm is corded, and the operation proceeds bloodlessly. An incision three to four centimeters in length is made, where the cuticle was scratched, and at a very slight angle across the course of the artery, thus facilitating finding it. It is separated from its venæ comites and divided, the proximal end ligated, the distal receiving the canula with the solution running, while it is being tied in. The tourniquet on the upper arm is loosened, and the infusion proceeds. Upon removal of the canula, the distal end of the artery is also ligated.

This method of saline infusion is very little used.

The fingers are to a certain degree endangered, from interference with their circulation, though commonly the superb anastomosis between the terminal branches of the radial and those of the ulnar arteries protects the digits. There is the advantage—particularly when blood transfusion is being used—that the capillaries act as a fine meshed seive preventing the passage of clots into the venous system.

2. Needling the Femoral Artery (Dawbarn's Emergency Method). This operation requires a large hypodermatic needle—or better, a long, slender, aspirating needle—a Davidson syringe from which the nozzle of metal or vulcanite rubber has been removed, and the usual solution.

TECHNIQUE. The Davidson syringe and the needle and the thread to fasten its base to the syringe should be disinfected by boiling.

To *Avoid the Entrance of Air* from a possibly leaky syringe, hold it and the sterile hand working it, beneath the surface of the saline solution.

To *Maintain the Proper Temperature* (*120° F.*) *of the Infusion*, the bowl containing it should be placed in a larger one, holding much hotter water. In this way, by adding from time to time to the heat of the outer bowl or pan, that of the inner vessel may easily be kept as hot as the hand can bear, which is about 120° F.

The Davidson syringe, needle and hot salt-water being ready, the operator now feels just below the middle of Poupart's ligament for the common femoral artery, here large enough in calibre to carry a lead-pencil. If the heart is still beating, this great pulse can almost always be felt. The aspirating-needle is now forced gently and directly into the

artery, entering it at right-angles; not with a sudden plunge, but by a slow, rotary movement. As soon as the point is within the lumen, bright red blood will fill the needle instantly; whereupon it is held very firmly and steadily in place while an assistant slips over the base of the needle the end of the syringe, already filled, and ties it in place with a thread. The solution is now thrown into the arterial current steadily, and necessarily slowly, which last is an added point in favor of this plan. It takes nearly one-half hour for a pint to enter.

If the subject be fat, an aspirating needle is preferable to the hypodermatic, which would here be too short to be held in place steadily; though indeed, lacking the former long needle, a simple, long incision through the fat may be made, enabling one to approach the vessel more nearly and readily with the fingers.

This operation was first used in 1891, and was first described in the New York *Medical Record*, January 12, 1892. It is especially intended as an emergency method,—in the absence of canula, scalpel, retractors and other implements used in the customary intravenous method, and also to replace this latter when the superficial veins are very small, or to be found with difficulty.

It has been successfully and safely used a considerable number of times by various physicians. The writer has reported in the medical journals six of these instances in his own experience.

Should it be preferred to employ a fountain syringe, rather than a Davidson, we must remember that the intra-arterial pressure is considerable, even when dissolution is not far off. It will be necessary to elevate the bag of the syringe five or

six feet, for safety aud efficiency; because in experiments upon dogs after bleeding them, the writer has found that if the reservoir be much lower than this, the blood may actually pass up the needle and enter the tube, instead of the salt-water being forced by gravity down into the arterial current.

The only objection (a self-evident one) to the emergency device of needling the femoral is the hesitancy naturally felt to pierce so large an artery; and this should vanish when one reflects that the most prominent plan now used by surgeons for aneurisms so placed as to be inoperable by ligation, and yet threatening rupture, is that of Macewen, of Glasgow. This is needling, and in it long needles are thrust, a dozen or so—into the sac, and left for many hours, to cause quicker deposits of fibrin on the walls—and this with benefit, as a rule.

If a diseased vessel can safely stand such treatment as this, it seems a mild inference that a sound artery can bear a single needle for a single half-hour. And such has been our experience so far.

It has also been noted by Ballance and Edmunds, in their excellent book upon arteries, that the common femoral is exceedingly thick-walled; which fact adds, of course, to the safety of this method.

It is of course desirable to use at the same time inversion of the patient (extreme elevation of the hips), and to pour two or three quarts of hot salt-water into the rectum by gravity. Indeed, if the symptoms of anæmia be not acute, or the probability of impending shock great, the latter plan alone is sufficient. But as Dr. Kemp has demonstrated (see page 27, Fig. III.), the rectal route stimulates the heart chiefly, at first, by the *heat* of the infusion, and that it will be a quarter of an hour or so

before water so introduced will have entered the bloodvessels in large amount. Hence in instances of urgent haste, this or other intravascular methods must always be preferred to the rectal or subcutaneous routes, if one plan alone is to be selected.

II. Intra-Venous Infusion.—We shall now describe infusion into a superficial vein by the most desirable technique.

Apparatus.—A large, graduated, glass irrigating jar with rubber tubing, and capable of holding at least two liters, is preferable to any smaller vessel. This is the average amount to be used for the prevention of shock in the adult. A glass vessel is preferable to any other reservoir, because permitting us to note the rate of flow. This should never be faster than a liter in ten minutes. It is a common mistake to overstimulate and thus oppress the heart by a greater speed than this.

In hospitals the irrigator is supported by a vertical rod, which can be raised or lowered on the stand of which it is a part. The jar should contain a bath thermometer, and when infusion is being performed should be wrapped about with a sterile blanket or large towel, to prevent a rapid fall in the temperature of the fluid. In emergency we often use a fountain syringe, and estimate the proper heat of the salt-water by the sterile fingers, 120° F. being about the hottest the hand can support. A few degrees higher, and the proper temperature would be unobjectionable.

The tubing is fitted with a transfusion canula, which is of such diameter as easily to enter the vein, and either ends by a blunt, oblique tip, or by

a very slight knob. It is well to keep on hand both a size for adults and one for children. (In emergency a medicine-dropper or even a quill, boiled, will suffice.)

Many of these canulæ are furnished with a stopcock for regulating the speed of flow, or a sterile artery forceps may be used to clamp the tube, laterally, near the canula. This, however, may as easily be accomplished by elevating or lowering the reservoir.

In addition, various instruments are needed, as will be seen in the description of the operation. For a more satisfactory understanding of the same we show two plates which demonstrate the anatomical relations of the parts at the elbow joint. (See Fig. LI.)

Operation.—The arm is corded, preferably by a large elastic tube, rubber bandage, or tourniquet. This is tightened enough to make the veins swell, but not enough to stop the pulse at the wrist. As a rule, the median-basilic vein is the largest at the bend of the elbow. Whichever vein is apparently the largest here, is to be chosen. If the one mentioned, then it must be remembered that if the operator is reckless enough to cut not only completely across the vein but also through the bicipital fascia beneath it, he may wound the brachial artery.*

If the patient be conscious, vigorous muscular exertion of hand and forearm will aid, after cording, the distention of the veins. If unconscious, flexion and extension of wrist and elbow, again and

* In the old days, when bleeding was chiefly done by the surgeon-barbers, whose knowledge of anatomy was of the slightest, this accident was the commonest source of both varicose aneurism and aneurismal varix—a connection, either indirect or direct, being maintained permanently between the artery and vein thus wounded.

FIG. LI.

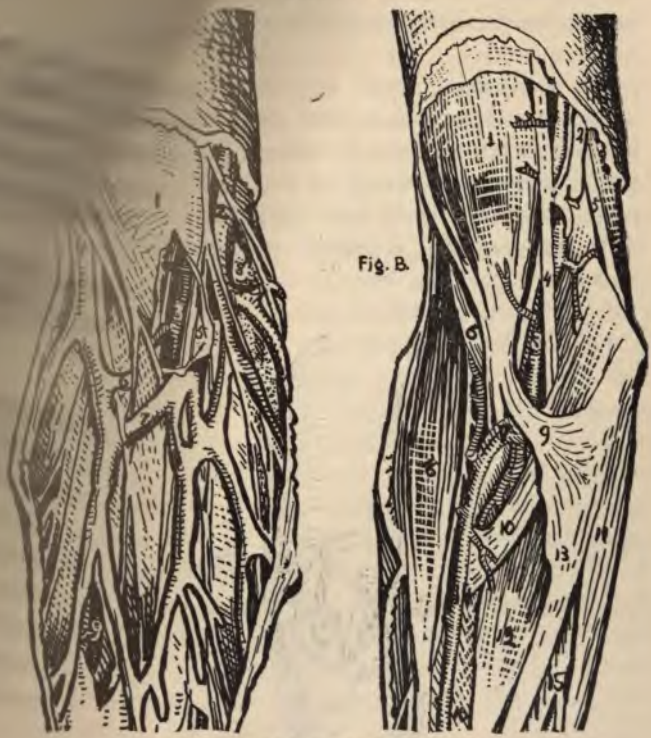


Plate Modified Slightly from Weiss.

FIG. A.

1. Fascia covering Biceps Muscle.
2. Basilic Vein, with Internal Cutaneous Nerve.
3. Brachial Artery with Venæ Comites.
4. Cephalic Vein, with External Cutaneous Nerve.
5. Median Nerve.
6. An occasional Communicating Vein, joining Venæ Comites.
7. Median-Basilic Vein.
8. Lymphatic Gland.
9. Radial Artery at Middle.

FIG. B.

1. Biceps Muscle.
2. Basilic Vein, cut.
3. Brachial Artery.
4. Median Nerve.
5. Ulnar Nerve.
6. Brachialis Anticus Muscle
7. Origin of Radial Artery.
8. Supinator Radii Longus.
9. Bicipital Fascia.
10. Pronator Radii Teres.
11. Flexor Carpi Ulnaris.
12. Flexor Carpi Radialis.
13. Palmaris Longus.
14. Radial Artery
15. Flexor Digitorum Sublimis.
16. Flexor Pollicis Longus.

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gature is easily used to tie the vein just above the
ut in it. Immediately after tying the vein upon
he canula the cord about the upper arm must be
emoved.

In ending a fine stitch or two suffice to bring together
he skin edges. When properly performed, this little
peration should not cost the patient the loss of ten
rops of blood. Carelessly done, it may add, instead,
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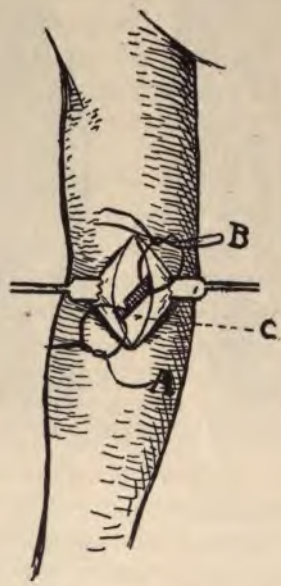
non mistake of the beginner is to forget to remove
he constriction on the upper arm,—whereupon
he pressure shortly bursts the vein at some point
elow this,—and the infusion into the cellular tissue
romptly causes a visible and tangible swelling
eneath the skin. Another mistake is to use force
r a canula too sharp at the point, and to drive
he instrument between the coats of the vein, in-
tead of into its lumen.

It is the custom of the writer to direct that every
atient being prepared for a major operation by
having and sterilizing the skin a number of hours in
dvance of the time for operation, shall also have
ne elbow-region sterilized; for one cannot always
ell in advance what patients will require saline in-
usion before they are removed from the operating
able, to prevent shock that would otherwise de-

* The canula [illegible] wound with the solution flowing,
o prevent the entrance [illegible] vessel, the danger of which will
hortly be described.

again, and "milking" upward, in either case, will help to make visible veins that otherwise could not be seen.

An incision of about one and a half centimeters suffices to expose the same length of the vein. A curved artery forceps, or other blunt instrument, is used to separate it from its bed and lift it gently out of the wound. It is now ligated as low as possible, with fine catgut. A second piece of this is passed about it higher up, but not tied.



Next the vein is divided transversely, with straight scissors, to the extent of one-half its circumference. The cut is placed low down, as near to the tightened ligature as conveniently can be done; but, of course, the cut is above this ligature.

The canula, with trickling stream,* is now in-introduced toward the heart, as far as it easily can be, and is tied in place by the second ligature named. This, however, is to be simply a "bow-knot;" the loop is not drawn completely through. Hence, upon the removal of the canula, this same ligature is easily used to tie the vein just above the cut in it. Immediately after tying the vein upon the canula the cord about the upper arm must be removed.

In ending a fine stitch or two suffice to bring together the skin edges. When properly performed, this little operation should not cost the patient the loss of ten drops of blood. Carelessly done, it may add, instead, to the hemorrhage it is intended to treat. A common mistake of the beginner is to forget to remove the constriction on the upper arm,—whereupon the pressure shortly bursts the vein at some point below this,—and the infusion into the cellular tissue promptly causes a visible and tangible swelling beneath the skin. Another mistake is to use force or a canula too sharp at the point, and to drive the instrument between the coats of the vein, instead of into its lumen.

It is the custom of the writer to direct that every patient being prepared for a major operation by shaving and sterilizing the skin a number of hours in advance of the time for operation, shall also have one elbow-region sterilized; for one cannot always tell in advance what patients will require saline infusion before they are removed from the operating table, to prevent shock that would otherwise de-

* The canula is inserted into the wound with the solution flowing, to prevent the entrance of air into the vessel, the danger of which will shortly be described.

velop. The operation of infusion is demonstrated in Fig. lii.

FIG. LII.

Hot saline infusion into the Median-Basilic Vein, for the Prevention of Shock

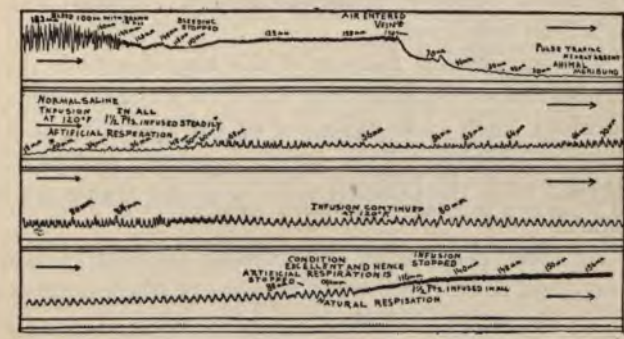
Danger from the Entrance of Air into the Vein.—Artificial Respiration, and Infusion at 120° F., if, as it should be, the solution is ready, at hand, the best Treatment for this Condition.

Regarding the possible entrance of air into a vein, special caution should be exercised. Though some have noted the sibilant sound indicating this accident while performing infusion (carelessly), and yet without bad result, and although considerable quantities of air have been injected experimentally into the veins of dogs and horses, and apparently without deleterious effects, yet statements that the entrance of small quantities of air need not be a

source of anxiety, we believe to be pernicious teaching,—and to lead to carelessness. That serious results *may* follow connot be controverted. The fatal result from the entrance of air into the deep jugular vein, if this is wounded during neck operations, is well known.

In Fig. liii. at the point* indicated on the chart, air accidentally entered the femoral vein of the animal, and immediate collapse followed.

FIG. LIII.



Entrance of Air into the Femoral Vein.

*Explanation of Tracings—Entrance of Air Into the Veins.**

Normal blood pressure, 182 mm.

Venesection, 100 cc., and pressure falls to 110 mm.

Pressure allowed to readjust itself, and it rises to 140 mm. We were performing infusion and inserting the canula when air entered the circulation. At the sudden entrance of air into the femoral vein, pressure immediately fell to 18 mm., and the heart-

*It was intended to perform infusion and venesection simultaneously and observe the results.

beat became intermittent and hardly perceptible, the animal moribund.

Artificial respiration and infusion at 120° F. with normal saline were begun at once. When the pressure reached 88 mm., artificial respiration was stopped, and natural respiration carried on. Infusion continued until the blood pressure had risen to 116 mm. In all, 750 c.c. of normal saline solution at 120° F. were infused. The blood pressure after the infusion was stopped continued to rise to 150 to 156 mm., where it remained stable. Animal is in excellent condition.

The interesting feature of this experiment is that the entrance of the air into the vein was entirely by accident, such as would occur on the operating table during infusion. The canula loosened and partly slipped from the femoral vein, with the above noted result.

Artificial respiration and infusion are clearly demonstrated to be the proper treatment when entrance of air into the circulation has occurred.

3.—*Infusion by Opening a Vein in the Operating Wound and Infusing Directly.* It is enough to say upon this point that we naturally select whatever vein is most readily obtained; but, as a rule, with occasional exceptions, it is best to close the veins of the wound and the wound itself in a major operation; and by a trained assistant to infuse meanwhile elsewhere, as at the bend of the elbow, rather than to keep the operation wound open for twenty minutes longer, as the introduction there of 2 litres of saline infusion would require.

Needling a Superficial Vein (*Kemp's Modification*). The usual constricting band being applied, also the usual precautions ensuring asepsis—a hypo-

dermatic or an aspirating needle, attached to a fountain syringe, is employed. This is thoroughly boiled. While the fluid is flowing freely from the needle, the superficial vein, made tense by over-distension, is pinched up between the fingers only, and the needle passed at right-angles into the vein and then the point turned toward the heart. If plunged in or pushed too forcibly it may perforate both walls of the vein, yet, if such occur, withdraw it partially and it will generally enter the vessel successfully. If the vein is not entered there will be immediate infiltration of the fluid about the needle, œdema in the tissues. A simple aseptic pad suffices as a dressing. Slight pressure will check any hemorrhage. This method is rapid, simple, and nearly painless. It requires, however, a rather thin subject, and very distinct and large superficial veins to be successful. As with needling the femoral artery, a cut may be made, in fat subjects, in order to approach the vessel more nearly.

Venesection at times being employed in conjunction, to "wash the blood," as in uræmia, the operation of venesection is included herewith.

Venesection or Phlebotomy Described.

As in saline infusion at the bend of the elbow, the arm above should be corded, and if the veins are not thus made to stand out readily, the patient is directed to work his fingers, alternately squeezing and relaxing, thereby forcing more quickly the arterial blood into the venous radicles. The skin-cut is trifling in length—just long enough to expose the least surface of the vein, which is thereupon cut partly across. Being under tension the blood some-

It is well to enter the needle at the angle of juncture of two veins.

times comes forth with such a spurt as to be a little alarming to the beginner; but his natural first thought that he may have cut an anomalous artery will be quickly dissipated as he observes the very dark color and steady flow, rather than the brighter red, and flow "per saltum," of arterial hemorrhage.

For an adult, a half liter is perhaps an average amount to withdraw at a sitting; stopping short of this if faintness supervene. This amount may, of course, be increased considerably, if at the same time that venesection is performed upon one arm the act of infusion is being carried out upon the other.

The after-treatment is simple; the arm is uncorded. If the subject be fat, and hence the cut require it, a skin-stitch may be taken. But usually a compress of sterile gauze is alone needed, which readily checks the oozing and is bound in place by surgeon's plaster or a bandage.*

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* Phlebotomy is a curious instance and an extreme one, of how medical fashions and opinions may change. In the days of our grandfathers bleeding was used almost as frequently and indifferently as prescribing a laxative. People were bled to relieve their feelings, and for other equally good and substantial reasons. To-day, on the contrary, it is so little employed that the average non-surgical doctor would hesitate as to the necessary steps if called upon to do it. As is so often the case, the truth lies between these extremes.

For puerperal convulsions in subjects not anæmic, for the relief of many of the symptoms closely following the menopause, for the plethoric, full-blooded people who will not stop eating and drinking in excess, in the congestive type of sunstroke, in poisoning by illuminating gas, in the first stage of sundry sthenic inflammations, and in other instances too many for this short treatise to touch upon, it is a weapon of extreme value for good and by no means should be discarded.

Its use in conjunction with blood-washing is elsewhere mentioned.

Solution Employed.—The fluid should be the normal (really the decinormal) salt solution, which is six parts of table salt per thousand, boiled and filtered; roughly a heaped teaspoonful to the liter or quart. In this proportion it about corresponds with the saline strength in the blood serum.

This is as good practically as the more complicated formulæ, resembling more closely the exact chemical composition of the blood-serum.* The salt should be pure. Some cheap and impure varieties of table salt contain ingredients that may even be dangerous.

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*These formulæ are hence omitted in the text to avoid confusion, as the normal saline solution is the most practical We note them for reference:

(A.) *Artificial Serum.*

Grs. 50 ..... Sodium chloride
Grs. 3 ..... Potash chloride
Grs. 25, āā ..... { Sulphate soda / Carbonate soda
Grs. 2 ..... Phosphate soda
Oi ..... boiled water

(This is the formula of A. Pearce Gould, in Treves' "System of Surgery.")

(B.) *Szumann's Solution.*

FORMULA.

Parts 6 ..... Sodium chloride
Part 1 ..... Sodium carbonate
Parts 1000 ..... Water

Hayem's solution, see under Hypodermoclysis.

(C.) *Locke and Hare.*

gm. 25 ..... Calcium chloride
gm. 1 ..... Potass. chloride
gm. 9 ..... Sodium chloride
Sterile water q.s., a liter.

(One bottle of the commercial fluid when diluted to a liter gives a solution of this composition).

The use of blood transfusion (mediate) or of defibrinated blood, both for treating post-hemorrhagic conditions and shock have been entirely dropped, as no more effective at the moment than saline infusion and being dangerous, both from possible embolism and from the certainty that every blood-cell so introduced will speedily break down, threatening to clog the liver and kidneys with the waste products of destructive or retrograde metabolism of tissues.

The infusion of milk, as some have suggested, is also liable to cause fat embolism. Cow's milk is often faintly acid in reaction, too, which is distinctly objectionable.

Normal saline solution therefore (in the proportion of a small drachm of salt to a pint of sterile water —grm. 4 to a half liter) is the best fluid for our purpose.

Quintin and Julia, and later, Hallim, experimented repeatedly with sea water and normal saline solution. The sea water was diluted to a point at which it would freeze at the same temperature as normal saline solution; continuous infusion was performed upon animals; and they claim that sea water causes more profuse diuresis than the saline; that the specific gravity keeps higher and the chlorides excreted are more abundant, and conclude sea water to be a better diuretic and eliminative than normal saline solution, as the urine contains more solid material.

Sources of Error.

We offer the following criticisms: 1. The total quantity of salts infused in the sea water was not computed. 2. One would expect the specific gravity of urine following the infusion of sea water to be higher than that resulting from normal saline solution, on account of the great amount of solid material to be eliminated, and there are more chlorides in the sea water, hence one expects more in the urine. 3. The temperature of the infusion is not noted. 4. The long-con-

tinued infusions have no parallel in practical clinical use, nor was the condition of the kidneys after infusion pathologically noted by autopsy, as compared with healthy organs. Urinary examination demonstrates albumin was not produced; time of this examination is not noted, also whether or no water was ingested before this examination, etc. 5. A drug may be a diuretic physiologically, yet, clinically, it may aggravate a congested kidney; artificial congestion of the kidneys was not produced and then the solution tested as regards its effects, nor were clinical applications reported. We believe the technique was not scientifically accurate and that the conclusions advanced are therefore incorrect.

In the *American Journal of Physiology*, vol. iv., no. 1 there is an article entitled, "Effects of Venous Hemorrhage and Intravenous Infusion in Dogs," by Percy M. Dawson, M.D.

The recording apparatus was by means of the œsophageal balloon; the average temperature of the infusion was 41° C. (105–106° F.)

Solutions were normal saline, also stronger up to 1 per cent. NaCl, and NaCl and Calcium Chloride, plus KCl of various strengths, and NaCl plus $NaHCO_3$ (alkaline) etc. An interesting study also was made concerning the blood following hemorrhage.

His conclusions are:

1. From observations on pulse and respiration there is no evidence that variations within the limits above described in the composition of the fluid infused have any influence on the immediate recovery of the animal. 2. Examinations of the blood afford no evidence that such variations have any influence on the character and rapidity of regeneration of the blood. 3. Ringer's solution containing as much as 0.026 per cent. $CaCl_2$ are dangerous.

In the animals that recovered effect of infusion on rate and strength of heart beat and on depth and frequency of respiration was not striking. A gradual return to normal sometimes did not appear until after infusion had been discontinued.

That improvement was due to infusion seemed doubtful when blood withdrawn was as small as 1.7–2.7 per cent. of

body weight, but most lost 4–5.5 per cent. and the benefit was then obvious.

As far as pulse and respiration were concerned, all fluids except Ringer No. 1 seemed to act equally well,—moreover the regeneration of the blood appeared to be uninfluenced by the fluid infused.

Other conclusions concern regeneration of the blood, and are not here set down.

Our criticisms are as follows:

1. The recording apparatus is a poor one, causing respiratory interference, and also cardiac, and hence militates against a correct method of anæsthesia.

2. Infusion. The author notes very little effect on the heart and respiration during infusion. The effects as regards the rate and strength of heart beat, or the frequency and depth of respiration, he states were not striking, especially if a moderate amount of blood had been withdrawn.

These facts are due to the error as regards the temperature of the infusion employed. He infused at 105–107° F. (41° C.) upon the average, and such results are therefore to be expected. These low temperatures have little noticeable effect in any case, unless the amount of blood withdrawn has been large. The proper temperature, 120° F. (48–49° C.) will give instantaneous and marked stimulating effects on the heart and respiration, and cause general reflex vascular contraction. It will do this in the normal animal, either when there is a slight hemorrhage, or when a severe hemorrhage.

3. Regarding the fluid for infusion, normal saline 0.6 per cent. of NaCl we believe most bland and least irritating and the safest, and sufficient should be infused and at the proper temperature, 120° F. CaCl is confessedly dangerous.

4. In the fatalities no record is made as to whether pulmonary œdema from too rapid infusion and a hyperdistention of the right side of the heart were present or not.

..... "The Use of Alkaline Solutions in Surgical Shock."

By W. H. Howell, M.D., *American Journal of Physiology.* Vol. IV,

This paper called attention to the striking individual differences shown by healthy animals in serious operations, some maintaining a good blood pressure and normal heart rate, while others quickly fall into a condition of shock—exhibiting a very low pressure and a rapid, feeble heart beat. It was shown that two important vascular symptoms of shock are often disassociated in operations on the brain, especially that a condition of cardiac shock often results, the heart rate being increased 100 per cent. or more and the beat becoming feeble, while the blood pressure remains within normal limits. Shock was produced in operations on the cerebrum without much hemorrhage, and alkaline solutions, Na_2CO_3, 5 per cent injected into the veins, or into the rectum. In moderate shock, pressure 60–70 mm., the alkaline solution brought the pressure back permanently to normal limits, 100 m.m., or more, and caused a marked increase in the force of the heart beat. In profound shock, 20–30 m.m. in pressure, the infusion raised it to 60–70 m.m. and brought back a strong heart beat. The effects produced were relatively permanent, lasting for one or more hours, and it was suggested that repeated injections at certain intervals might result in a permanent recovery of normal vascular tone. Attention was called to the statement that when infusion was the method employed care must be taken not to use an excessive amount, not more than sufficient to increase the total alkalinity of the blood by 0.1–0.2 per cent. Rectal injections of 5 per cent. of Na_2CO_3 in normal saline were recommended as a safe procedure. Experiments made on serums obtained from an animal in shock and injected into a normal animal indicated that shock blood contains no poisonous substances.

Comment.

We personally see no advantage in this method since the danger of undue alkalinity is a real one. From a physiological standpoint, it may be well enough to assume 100 m.m. of blood pressure to be within normal limits, as so noted in hits article, but clinically a proportionate loss means much

lowering of the blood pressure and severe shock in the human subject.

Assume, for example, a dog with 135 m.m. as normal blood pressure; shock produced and pressure runs at 105–110 m.m.; pulse twice as rapid, but feeble; pressure is within normal limits, physiologically.

In surgical shock with a feeble heart, 140–145 beats to the minute (nearly twice the normal rapid ty) we would not cons der, with loss of pressure though only one-fifth to one-fourth of the total normal degree, that the ten-ion of the pulse was within the normal limits. By employing normal saline solution, at 120° F., we have raised the pressure after severe hemorrhage from 20 m.m. to 140 m.m.

The specific effect of normal saline solution in producing increased renal secretion has already been demonstrated.—See Experiments.

It does not seem so widely known, as should be the case, that plain warm water, devoid of sodium chloride, must not be used intravascularly. For example, in a recent article in the *Medical Record* upon "Saline Infusion," the author, Dr. Reilly, copies, without adverse comment, a most dangerous bit of advice from Messrs. Bosc and Vedel; namely, that "ordinary water is non-toxic, not very destructive to the red corpuscles, and might be used in an emergency." Also in the "Transactions of the London Obstetrical Society" (meeting of December 6, 1893) may be seen a similar suggestion by a member, Dr. Horrocks, who was of opinion that the salt was a luxury, but not a necessity. He did not claim, however, actually to have ever used plain water in this way, and no member present agreed with him in advising it. It is certain that whosoever tries this will, if the water be used in the customary large amount, kill his patient with quite indecorous speed by a wholesale disintegration of the red discs. The

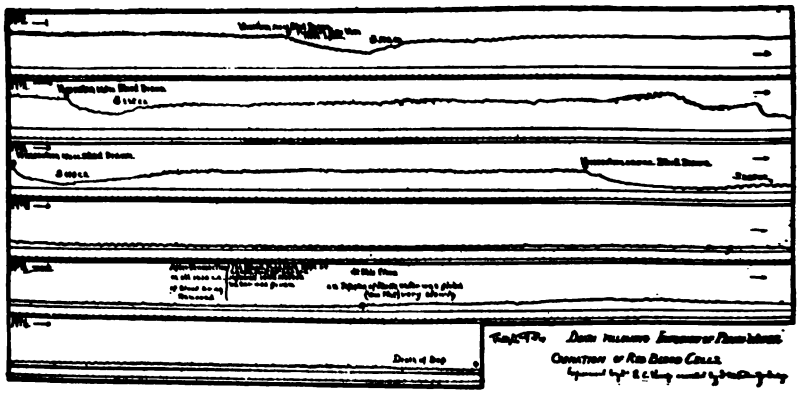
addition, however, of even so small a proportion of salt as six-tenths of 1 per cent. renders it safe for vascular infusion. Perhaps a quotation from an experiment of mine at the Columbia University Physiological Laboratory may emphasize this point, which surely needs emphasis. "On May 15, 1891, I operated on large dog, weighing before operating 16.77 kilos. On the one-in-thirteen hypothesis (of blood to body weight) his weight of blood would have been 1290 grams, or allowing for the specific gravity of blood, about 1222.75 c.c. The canula of the mercurial manometer was introduced into the right carotid. The right femoral was used for the bleeding, the left femoral for injection of the hot salt solution. Professor Curtis superintended the working of the kymographic needle. Dr. F. J. Brockway assisted me. We drew 563 c.c. of blood."

Upon attempting to replace this and a smaller subsequent bleeding by the salt solution with which at various temperatures I was experimenting, a mistake—a most interesting and instructive one—was made. "Dr. Brockway and I each supposed that the other had added the salt to the hot water, whereas in fact neither had done so. And within a minute after receiving a considerable amount of this plain water injection the animal died."* Previous dogs, bled to an equal degree, had done beautifully and recovered under saline infusion. Hence we were much puzzled until Professor Curtis asked if the salt had been added, and stated that without it water in considerable amount will kill almost as quickly as prussic acid, and in the way already named.

*Read at a meeting of the Surgical Section of the N. Y. Academy of Medicine, held Nov. 9, 1891. In both this and all experiments upon animals I have used morphine enough to prevent suffering.

Fig. LIV. demonstrates Dr. Dawbarn's experiment, being repeated eight years later by Drs. Kemp and Malcolm Goodridge, also at Columbia University, with the following result:

FIG. LIV.



"Death Following Infusion of Plain Sterile Water."
(Red Blood Cells are Crenated.)

Repeated small venesections were performed. After the blood pressure had remained stable for several minutes subsequent to these operations, an infusion of a pint of plain sterile water at 120° F. was given slowly. There was a slight evanescent rise of pressure, followed by a rapid fall of the same and the death of the animal. Microscopical examination of the blood showed marked crenation of the red blood cells.

On the other hand, if a preliminary saline infusion be given, a considerably greater quantity of blood can be removed than is otherwise permissible; and we have even subsequently infused a large quantity of plain water and manipulated the viscera with

Recognizing that something more than the broth would be spoiled by too many cooks, in this case if the salt were forgotten, a lady has suggested that the surgeon ought to taste the salt solution before inserting the canula.

roughness without causing the death of the animal, so great is the stimulating effect of the preliminary saline infusion at 120° F. We do not, however, advise infusion before operating upon patients, as the greater resultant blood pressure excites bleeding from even the smallest vessels.

In another animal, after venesection, infusion of normal saline was given; bleeding was then continued, also infusion, practically washing the blood. The pulse and respiration continued excellent, although the blood became so thin that it would not clot, and the blood count gave only 400,000 red cells. This demonstrates that a large volume of blood may be lost, and yet in spite of the loss of red cells the saline replaces it successfully, so that both cardiac and respiratory functions continue. The immediate danger from loss of blood is the fall in blood pressure to a point where the circulation cannot be maintained, and the indication is to raise the pressure in the vessels. As a cause of death, the loss of enough of the oxygen-bearing red corpuscles to arrest respiration might be feared, but it has been demonstrated that in animals blood may be withdrawn until respiratory functions have ceased and the heart action is scarcely detectable, yet if one-half of the blood remain in the system, and a sufficient quantity of saline solution be introduced—at the proper heat—the functions of heart and lungs are restored and the animal recovers.

Moreover, in pernicious anæmia the loss of red corpuscles amounts at times to as much as 90 per cent., yet respiration is not seriously impaired.

Some observers, as Pierre Delbert, claim that normal saline solution has a decided hæmostatic action, though we are inclined to believe that if such tend-

ency to clotting exists, it would probably be overcome by the increased tension caused by the infusion. To quote, "Pierre Delbert in 1889 observed the blood clotting directly as it was flowing from the vessels, following an intravenous injection of saline solution, and it is claimed that his observations have been confirmed. Dr. Reilly, in the *N. Y. Medical Record*, Nov. 12, 1890, cites such a clinical case and states that the theory has been advanced that it produces hemostasis by exciting the contraction of the arterioles and a migration* of the hæmotablasts from the hæmatoformative centres. These are destined primarily to replace the blood lost by hemorrhage, but arriving in a serum yet rich in fibrin they are precipitated and form the nucleus of a clot. Its two-fold function becomes especially apparent in internal hemorrhages, such as hæmoptysis, and the hemorrhage of typhoid fever." He states it is advisable in the last two conditions, unless there is immediate danger of death, to allow the fluid to run very slowly on account of the increase of blood pressure.

This claimed hæmostatic action of saline solution has been noted by Dr. Kemp, under "Hypodermoclysis," and the use of salt water by mouth in pulmonary hæmorrhage in the Adirondacks. Indeed, the drinking of salt water to arrest such bleeding is a very old practice among the laity, but without positive proof of its value. Indeed, the present writer has heard the late Professor Loomis, a man of the widest experience, deny that it has any efficacy whatever.

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* Morton, *Ther. Gazette*, Vol. 12, 1896. Delamare, *Gaz. des Hopiteaux* p. 105. 1897.

The Proper Temperature for Infusion.

The proper temperature for the injection fluid, is *as hot as the hand can bear*, and this is about 120° F. or 49° C. (Of course, the temperature at the heart, when the great bulk of blood has diluted the slowly entering fluid, will be much lower than this.) There need be no fear of injuring the blood or other tissue by such heat. Very many times the writer has now used it, since 1891, and never with cause for subsequent regret. This point seems not at all well known, as yet, in the profession; and nearly all the text-books still advise infusion at about 100 to 105° F. The higher temperature here recommended is very stimulating to the flagging heart, and maintains the tone of the muscular tunic of the vessels.* This is well illustrated in the photographs herewith of kymographic carotid tracings at various tempera- (see Figs. LV.–LX). So recently as last winter Dr. Robert Coleman Kemp, at the Columbia University Physiological Laboratory, in pursuing some investigations in a somewhat different line, had occasion to repeat my manometric and kymographic experiments of some eight years ago, made in the same laboratory, and reverified their correctness—he, too, finding that at 120° F., the tracings showed the best

*Whoever has noted the vigor with which unstriped muscle everywhere responds to the use of heat—for example, the much stronger and decidedly more lasting uterine contractions resulting from hot post-partal injections, as contrasted with cold ones, must see the inherent probability (which is now a proven fact) that such unstriped muscle, forming as it does a most important tunic of the blood vessels, would be greatly aided by hot infusion in maintaining its tone.

results upon the heart and vessels. His statements were published in the *N. Y. Medical Journal*, Jan. 29, 1898.

To maintain the desirable degree of heat the reservoir containing the water should be wrapped in a large, hot, sterile towel or sterile blanket during the time occupied by the act of infusion.

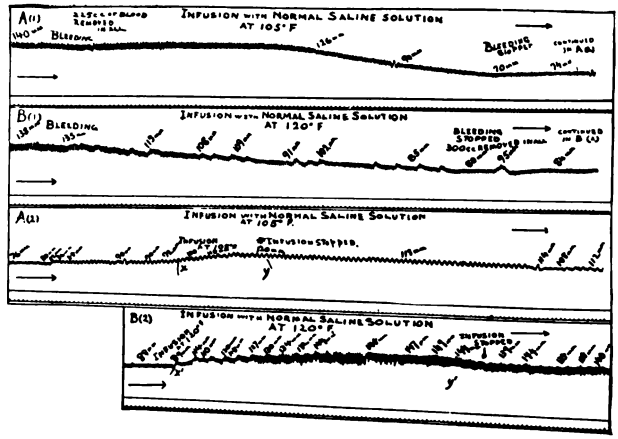
In Dr. Reilly's article quoted, he mentions a conclusion of Athansin, a French experimenter, upon this matter of the proper heat, which I must believe to be an error. He says: "In animals, at least, solutions having a temperature of 165° to 175° F. can be safely used." Now, upon reference to Kirke's "Physiology." eleventh edition, p. 846, it will be seen that globulin coagulates at 70° C. (158° F.) and Dalton's "Physiology," seventh edition, p. 80, affirms that serum-albumin clots at 72° C. (162° F.)

It will be noted, however, that both 158° F. and 162° F. are about 40° hotter than the hand can support. as above stated. So that the temperature which we advise is, in this regard, a long way from being unsafe. The hand-test of the heat, as suggested, will be found both safe and accurate enough in actual practice.

By microscopic examination the blood cells are found normal, at 120° F.; at 130° F., however, some few are a little crenated. Hence, and since at this much higher degree of heat the heart and vasotonic effects are not so good nor so lasting, 120° F. should be the temperature selected.

Two animals were employed in the following experiment and the tracings secured are mounted parallel as a clearer means for comparison:

FIG. LV.



Comparative Tracings Following Infusion at 105° and 120° F.

Under A (2)—A section of the tracings of one minute duration of varying pressure, 114 m.m. to 118 m.m., was removed for lack of space at x, infusion was stopped above y.

The distance x—y equals distance x'—y', therefore in point of time. The tracings are absolutely accurate, but this arrangement was rendered necessary in order to bring the trace within the limits of the necessarily small illustration.

The greater stimulating effect of infusion at 120° F. is here clearly shown. The following figure illustrates the results most clearly:

FIG. LVI.

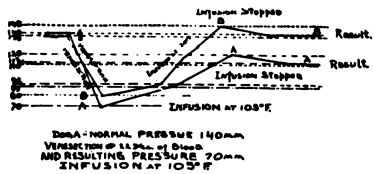


Diagram Demonstrating the Tracings at 105° F. and 120° F.

Trace B, normal pressure 138 m.m. Venesection and resulting pressure 80 m.m. Infusion at 120° F. is later given.

Trace A falls to 70 m.m. after 225 c.c. of blood is removed and circulation is allowed to readjust itself, the pressure rising to 80 m.m. before infusion is begun.

Trace A following infusion at 105° F. rises from 90 m.m. to 120 m.m., and then falls to 112 m.m., result of infusion as a stable pressure.

In trace B 300 c.c. of blood were removed, pressure falling from 138 m.m. to 80 m.m., and the circulation readjusts itself to 88 m.m. before infusion is begun.

Trace B following infusion, one-half pint normal saline at 120 F., rises from 88 m.m. in ten seconds to 114 m.m. and then steadied to 148 m.m., and then falls to 140 m.m. Result of infusion at a stable pressure.

The red blood cells were normal under the microscope after infusion 120 F., as well as after infusing at 105° F.

FIG. LVII.

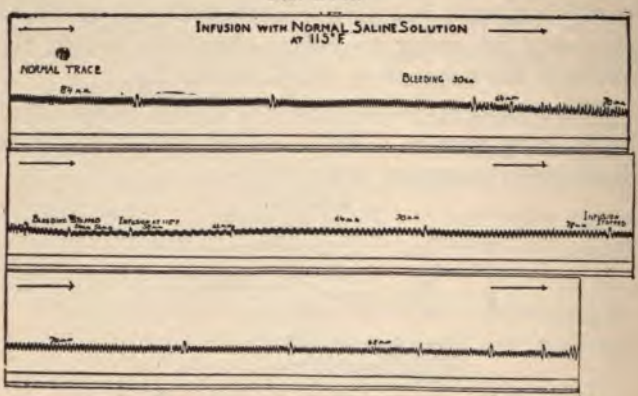
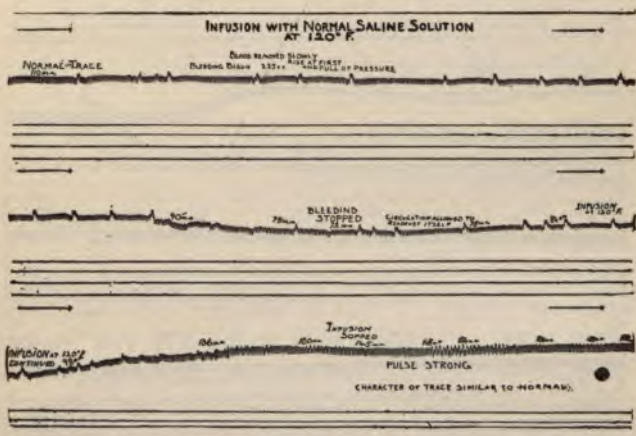


Illustration of Infusion with Normal Saline Solution at 115° F.

In this animal the normal pressure is 84 m.m. Venesection 50 c.c. Blood pressure falls to 56 m.m., then rises to 58 m.m., at which time infusion with normal saline at 115° F. On pressure rising to 78 m.m. infusion is stopped. Pressure gradually drops to 68 m.m., where it remains stable and the heart is of good force. Red blood cells are normal on microscopical examination.

In Fig. LVIII. we have an excellent illustration of the superior results obtained by infusing with a normal saline solution at 120° F.

FIG. LVIII.



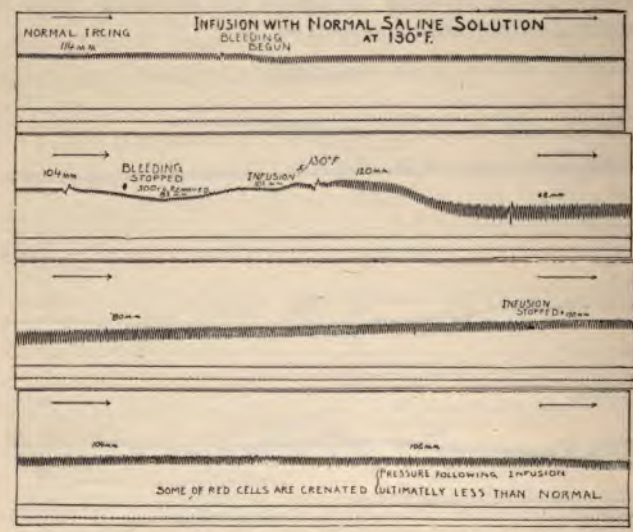
Result of Infusion of Normal Saline Solution at 120° F.

Normal blood pressure 110 m.m.; then venesection 225 c.c. Pressure falls to 72 m.m. Circulation is allowed to readjust itself and it rises to 84 m.m. Infusion is then began with normal saline solution at 120° F. Pressure rises rapidly to 136 m.m., when infusion is stopped. It thereafter continues to rise more slowly to 150 m.m., about which height it re-

mains stable. The pulse is strong and of good character. The tension as noted is better than previous to venesection. Red blood cells are normal on microscopical examination.

In Figs. 59 and 60 we have illustrations of the results of infusion with normal saline solution at 130° F.

FIG. LIX.

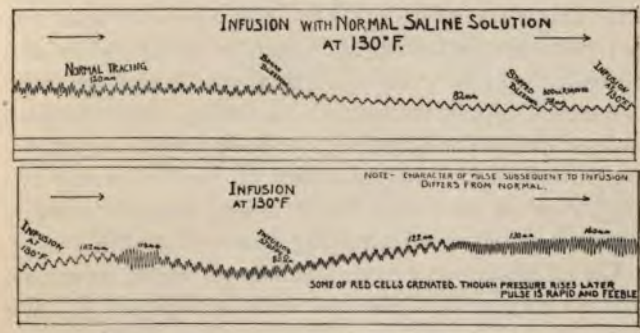


Infusion with normal saline solution at 130° F.

Normal pressure 114 mm.; venesection 500 cc.; pressure falls to 82 mm. Circulation allowed to readjust itself, and pressure rises to 102 mm.; infusion at 130° F. is begun; pressure rises to 120 mm.; pressure then falls to 68 mm. with more feeble heart action coincident as the infusion is continued, pressure gradually rises again to 120 mm. After the in-

fusion is stopped the pressure falls again to 106 mm. The fall of pressure during part of the period of the infusion and the character of the pulse at the time are noticeable features. The immediate stimulating effect of the infusion is not as great as following infusion at 120° F. nor is the final result. Some few of the red blood cells are crenated, as demonstrated by microscopical examination.

FIG. LX.



Infusion with normal saline solution at 130° F.

Normal pressure 120 mm.; venesection; pressure falls to 72 mm.; infusion at 130° F. begun; pressure rises to 102 mm., then falls to 80 mm. while infusion is being given. At this point infusion is stopped, pressure then begins to rise until it reaches 122 mm. It continues to rise thereafter to 130 mm. and finally to 160 mm. The character of the pulse, however, is rapid and feeble and differs in type from the character of the original pulse. Some of the red blood cells are crenated, as demonstrated under the microscope. In both tracings following infusion at 130° F. we note, therefore, that at no time is there as marked a sitimulating effect on the pressure as is produced by infusion at 120° F. In addition to this,

in one case, the resulting pressure from infusion at 130° F. was much less by comparison than was caused by infusion at 120° F. In the other case the resulting pressure was comparatively high, but the pulse was rapid and feeble and differing in type from the original pulse.

It would seem to us therefore that normal saline at 130° F. is unwise to employ for purposes of infusion since it causes crenation of some of the red cells, and that this effect on the blood would account for the peculiar and irregular results produced on the pulse-tension (see the two tracings, of which we have presented illustrations). Regarding intermediate temperatures for infusion, between 120° F.–130° F., we found that temperatures of 122° F.–122.5 F.–125° F. were no better for infusion, indeed, perhaps not so marked in stimulating effect as 120° F.

On microscopical examination we could, however, find no crenation of the red cells below 130° F. We were forced to conclude, therefore, that a higher temperature than 120° F. would not be advisable, and that infusion at 120° F. is the ideal method,—absolutely safe in every regard; and that this temperature gives us the best results and should always be employed.

We will next refer to some of the indications for infusion with normal saline solution.

First, and chiefly, for the *prevention* of shock in cases where the experienced surgeon has reason to dread this.

Again (although of less value) in shock actually present, from hemorrhage or from other causes. Also in the accidents of anæsthesia, such as heart failure under chloroform, etc. (We will devote the two succeeding chapters to Shock and Anæsthesia).

Among further indications for infusion, we note, from various sources, the following conditions in which it has been employed:

"Suppression of Urine.—The employment of infusion in this condition has heretofore been noted—thus, McBurney reports a successful case—suppression having followed removal of a large calculus from the kidney. See McBurney, Annals of Surgery, August 11, 1895.

Diabetes.—Lepine reports good results in diabetic coma, from the injection of saline solutions containing bicarbonate of soda. Garnier and Lambert have temporarily arrested the glycogenic functions of the liver, by normal saline injections.*

Sepsis, as in *Septic Peritonitis.*—Lejars and Michaux report its successful use in seven cases of peritonitis.†

Berrin reports a case of septic peritonitis cured by its use.

One successful case in "Sepsis caused by Osteomyelitis with Multiple Abscesses," is reported by Lejars.†

In Belladonna poisoning, Dr. Kemp suggests its value, as either belladonna or atropine soon appears in the urine, and elimination would be hastened on account of the diuresis produced by the saline. Care should be taken to employ frequent catheterization, belladonna causing retention not infrequently.

Ulcerative Endocarditis.—Dalchi reports its successful use in two cases of ulcerative endocarditis. In one case a liter a day was employed for five days.

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*Compt Rend., Vol. IV.

†*Prog. Medical*, Vol. viii.

‡La Med. Moderne, May 13, 1896.

Pyelitis.—Delbert has had good success from its use in pyelitis, and he believes that the increased amount of urine washes out the pelvis of the kidney and also helps to eliminate the blood toxines. (The present writer can state from personal experience that both enteroclysis and hypodermoclysis are of much value in pyelitis.)

Toxæmia Due to Colon Bacillus.—Vedel* has been able by the use of saline infusion to neutralize in rabbits the toxæmia due to intravenous injection of the toxines of bacilli coli communis.

It has also been advocated in Purpura Hemorrhagica, and with success also in Tetanus and in Painters' Colic. In mushroom poisoning, bleeding followed by infusion has been advised; as also in carbolic acid poisoning.

In arsenic poisoning, Dr. Reilly from experiments on cats believes infusion to be of service.

In grave jaundice, temporary amelioration is reported.

In extensive burns, Tomalisoni reports good results in experiments on dogs.

In epilepsy, Monet and Viret advocate it."

"In conclusion we may say that some of the indications for hot saline infusion are:

1. In all cases of severe hemorrhage.

2. Before (but only if there has been bleeding), during or after operation, to prevent shock; also, though less hopefully, when shock is already developed; also in threatened death from anæsthesia, under certain conditions. See chapters XII and XIII).

3. In all toxæmic conditions, as in uræmia, septicæmia, sepsis of diphtheria, cholera, typhoid, etc.;

*Independence Medicale, September 9, 1896.

and venesection may or may not precede it—depending on the individual conditions.

4. To replace the loss of fluid from the body, as in diarrhœa, cholera, cholera infantum, etc.

5. In certain cases of poisoning, whether vegetable or mineral.

6. In cases of imminent death from any cause, since it is so extremely powerful and prompt a *heart tonic.*"

Embracing as it does so wide a sphere of usefulness, it seems strange to us that in our standard works so small a space is devoted to this important topic of Saline Infusion.

We have, therefore, so far as the limits of a chapter of this small work would permit, endeavored to present the subject as fully as possible. Elsewhere is discussed the question which of the several routes is preferable—intravascular, by hypodermatic needle, or by enema and the differing indications for each.

SHOCK.*

CHAPTER XI.

BY ROBERT H. M. DAWBARN, NEW YORK.

If we study, the world over, the causes of fatality following major operations, we find either sepsis or shock at the head of the list. Of recent years there has progressively been a lowering of the mortality due to infection of wounds; but is this true of the proportion of deaths from shock? It has seemed to me that for many years little advance has been made in our method of handling shock. No surgical topic more deserves our research; none receives it so little. An infinite number of minor topics takes up the time of our investigators; but this, the great lion in the road to recovery, is avoided to a degree that is surprising. How can one help feeling astonished at such neglect who observes that even the most recent surgical text-books almost ignore it? For example, in New York State, two prominent works recently issued of 1240 and 1600 pages, respectively, devote the one, four, and the other, three pages to the entire topic of shock! The same is true of the largest and most recent London work on surgery, of 2272 pages,

* Read at the Ninety-Third Annual Meeting of the Medical Society of the State of New York, held at Albany, January 31 and February 1 and 2, 1899. Reprinted from the *Medical*

which devotes four of them to the greatest cause of surgical deaths (next to infection)—not much more space than is devoted to bunion!

Space precludes a discussion of the pathology of shock, and yet a few sentences are necessary in order to make clear the views upon which at least in part the treatment is based. Doubtless the last word has not yet been written on this subject. Nevertheless, the experiments of Professor Golz, of Strassburg,* have never been successfully contravened. They are well known to all surgeons.†

We may divide our cases of shock into, *first*, those in which the cause, whether a physical or a mental blow at the nervous system, partially abrogates the functions of the sympathetic nervous centers; *second*, where the cause partially abrogates the functions of the cerebro-spinal nervous centers, as well as of the sympathetic.

In the first group the brain does not succumb to the blow. It is still capable of performing its functions fairly well. The sympathetic nerves, however, no longer properly invigorate the cardiac ganglia, and the tone of all the blood vessels is also lost. Because of the weak heart-action the blood tends to accumulate in the veins. The patient bleeds inwardly, that is, into his own veins. The blood, like any fluid, must move in the direction of least pressure, and so it accumulates in the relaxed, dilated veins,

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* *Virchow's Archives* for 1875. "Ueber den Tonus der Gefässe und Seine Bedeutung für die Blut bewegung.

† Sherrington demonstrates there is a loss of plasma from the vessels during shock, and apoplasia continued for sixty hours or so after severe operation. He considers this as one of the elements in shock to be combated, and hence the further value of infusion to replace this loss is demonstrated.

leaving the arteries partially emptied. The condition in its resultant symptoms is identical with internal hemorrhage. I know of no surgeon capable of making a diagnosis between this not very uncommon type of shock and inward bleeding. It is interesting to note that Professor Hare has recently shown that death from chloroform narcosis is really death from shock; his words are: "The man is suddenly bled into his own veins and capillaries as effectively as if into a bowl."

We should note that in this, sometimes called the *erethistic* type of shock (to distinguish it from the commoner *torpid* or *apathetic* type), the victim is usually perfectly conscious until nearly the moment of death; occasionally, toward the end, is a little delirious or even convulsive, from cerebral anæmia. He is restless, tossing about; he is thirsty, and yet often often nauseated; he sighs for more air; his skin is cold, pale and wet; his pulse is rapid and feeble. Are not these, each and all the signs of inward bleeding? But they are just as truly the signs of the erethistic type of shock. I am personally cognizant of two instances in which a famous gynæcologist—a man of great surgical experience—treated a patient post-operationem for shock, but the autopsy showed the abdomen to be full of blood, due to a slipped ligature of the stump.

In one case (shock) the bleeding is *into* the paralyzed and dilated vessels; in the other (hemorrhage) *out* of the vessels. But the symptoms are one and the same, and are due mainly to lack of blood in the brain and heart.

In the second and commoner type of shock—the *torpid* or *apathetic*—not only the sympathetic sys- the cerebro-spinal centers, have felt

and partly succumb to the blow. The patient is, in the milder cases, mentally benumbed; in the worst ones, quite unconscious. Because of this benumbing of the higher centers, the signs of this, the commonest type of shock, necessarily differ very much from the first type described. He does not suffer, as would an active brain, from dyspnœa, nor is he restless, nor does he complain of nausea nor of thirst. He has, however, the cold, pale, sweating skin, the rapid, feeble pulse, the shrunken features. of inward bleeding. Often he has lost control of his sphincters. Sometimes he is a little delirous or convulsive—more commonly, simply in stupor. His symptoms are precisely those of hemorrhage, except as just stated; and the reason for the difference is obvious.

The only condition (save inward hemorrhage and occasionally a form of extreme sepsis) which can be confused with shock is fat embolism, and the differential diagnosis is not difficult. It is a special danger of fractures, and lacerations of, or operations upon, fatty *tissues*. At first, the lungs suffer most from the infarction; later if the patient survives and the fat is forced on through the pulmonary capillaries, the kidneys and other organs may also undergo fatty embolism. Five points aid in clearing up the diagnosis: (1) The time at which fat embolism develops. This, as compared with shock, is usually late, from to one three days after the injury. (2) The cyanosis, due to plugging of the vessels of the lungs. (3) The extreme dyspnea, with very rapid breathing and sometimes bloody foam or even hemoptysis. (4) The mental excitement which often ushers in the symptoms. (5) The presence of fat in the urine.

Causes of Shock.—.—These are properly divided into I. predisposing and II. exciting.

I. *Predisposing.*—Under the first head, fear is a considerable factor. I know personally of one fatal case in which the subject, shown by an autopsy most carefully made to have no apparent lesion or disease of any organ, died apparently of sheer cowardice, some hours before the time set for operating on piles. His agitation and fright rapidly increased, and he suddenly collapsed, dying within an hour, and with symptoms of shock. All measures tending to reassure patients and to calm them are of utmost value in preventing shock. This is one reason why the writer always prescribes whiskey and a little morphine with atropine an hour before operation. The patient, otherwise more or less frightened, takes his anesthetic in a calmer, an almost cheerful, frame of mind. Also, as these drugs are also analgesics, less ether or chloroform is needed than otherwise, and hence there is less danger from it.

We should not forget, as one peril from major operations under minor anesthesia, that a conscious patient must be nervously affected in an unfavorable way by hearing the saw grating through his bone, or the surgeon's orders to his assistants, or by seeing the bloody paraphernalia used, etc. All this tends to invite shock. To illustrate, an aspiring needle may safely be introduced in several directions into the brain of a patient who is under general anesthesia, whereas the same needle would probably cause prompt death from shock if driven into the brain of the same patient while conscious. Furthermore, a conscious patient whose thoughts

are diverted elsewhere, at the time of being cut, is apt to feel much less shock than one who is nerved to the ordeal he is expecting. It is easier to snap a tense thread than one relaxed. All military surgeons have noted that a soldier severely wounded in battle may not realize it at all for some time thereafter; and will suffer less from shock than if he were to lie down on the table in a mental attitude of expectancy, and while conscious receive an equally grave physical injury.

From the above points it follows that although one may, for example, amputate a thigh painlessly under cocaine* or other minor anesthesia, it may very possibly result in a greater degree of shock than would have followed general anesthesia.†

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* Crile has asserted that in his experiments when he cut off afferent impulses by cocaine "blocking," no shock was present, thus showing the important part afferent impulses play in producing this condition. He could not, however, thus reach the depressing impulses coming through the eyes, ears and thoughts of the conscious human patient.

† Quite recently the profession has taken up with a rush the suggestion of Dr. Leonard Corning, made many years ago, that by injecting a solution of cocaine into the lumbar region of the spinal canal, the cord above will be bathed and benumbed, and there will be in consequence a paraplegia of brief duration. Wonderful results are obtained in labor cases, and laparotomies and sundry other operations are often now being done under such anesthesia. But there are certain obvious dangers. Should infection be carried in by the needle (even though boiled) as it passes through the deeper layers of the skin, or by means of an injection fluid not quite sterile, the results must be perilous. It is also conceivable that the cord, which with the patient recumbent must be affected a long way up, may suffer from the inevitable primary contraction and secondary dilation of its vessels always produced by cocaine, and be affected adversely in

Under the heading we are discussing comes also impairment of vital energy by uremic or lithemic or diabetic troubles, or constitutional dyscrasias; by opium or certain other habits; by prolonged sleeplessness; by business worries or other anxieties; by recent illness; or by either infancy or extreme old age. Sometimes, too, there is a family inheritance whereby the slightest operation proves perilous; whereas, on the other hand, we occasionally find a man whom the severest measures ever attempted can hardly kill—such is his vital resistance to shock.

II. *Exciting Causes of Shock.*—These may come in the form of either mental or physical blows. We are now discussing the latter, mainly; and, regarding operations, there are four of chief importance. These are: (1) Loss of blood; (2) length of operation; (3) excessive or prolonged major anesthesia; (4) loss of vital heat during operation.

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consequence, though not strikingly, and perhaps much later on; especially so, if not absolutely sound in the first place. And finally the patient, though with eyes be bandaged and ears stopped, is THINKING none the less actively; and as we have said heretofore, is, being conscious, the more likely to succumb to shock—the mental strain aiding the physical to that end—than if he were asleep from the anesthetic. It will take not dozens, but statistics from many hundreds of cases to prove or disprove this. Meantime, this brilliant device is well worthy of trial in selected but not indiscriminate cases. Where, for example, a small operation is to be under cocaine, and by use of a very little in the usual way a painless result could be obtained, it seems to us unwarrantable to cause sensory paralysis of the entire lower half of the individual instead. It is like using a sledge hammer to crush a butterfly.

When used, it seems best to exhibit bromides by mouth to prevent the acute headache, otherwise a common result.

1. As to the first of these four: With advancing years a surgeon has an increasing respect for a drop of blood. Hemorhage is not the only cause of shock; indeed, one may die from shock produced by a blow on the abdomen, and without any bleeding. Nevertheless, hemorrhage is certainly the main cause. Shock is apt, in its severity, to be directly proportionate to the amount of blood lost.

2. As to the length of the operation, here is a matter too often neglected. In abdominal work, especially, speed is only second to asepsis as the leading factor in success. If the operation lasts an hour or more, in a given case, the patient is apt to "die cured;" whereas, with half the time, or less, the great sympathetic centers do not suffer so terribly from the exposure. The most successful gynecologist I know operates with a speed like a sleight-of-hand trick.

Since the introduction of anesthesia, the really rapid operators have become few; and not all surgeons seem to realize how prejudicial to the patient it is to prolong an operation for the purposes of demonstration to the bystanders. I think it would be well if certain operations of grave peril were more often parted in the middle, so to speak. In the enucleation of some great tumor of the neck, for example, which has already taken much time, and promises, with the careful dissectlon needed, to occupy as much more, and in which the patient is weak, here let us leave our work unfinished, apply a sterile dressing, and wait two or three days if need be, or until he is fit to bear the remainder of the cutting. Of course this is no new idea, but it is much less often adopted in practice than would seem wise.

3. As to excessive depth of major anesthesia, we all know that quite aside from the severity of the accompanying operation, this jeopardizes the patient's chances of escaping shock. Occasionally we see the surgeon permitting his assistant to keep the patient snoring heavily throughout. As a rule, this, which is an indication of deep paralysis of the velum palati is needless, and worse.

4. It invites also the fourth main cause of shock enumerated—loss of vital heat. Prolonged and profound anesthesia, as we all know, results in a heavy fall of bodily temperature. And, too often, careless exposure of the subject upon the table adds to this chilling.

Treatment.—It is the chief purpose of this paper to endeavor to emphasize the extreme value of certain means of preventing shock, which would otherwise develop. Upon this plan of campaign against this great enemy can we alone rely for better figures of mortality than those of the past. If we wait until shock has actually struck its blow, too often that blow proves deadly. Where the gravity of the operation or severe loss of blood or other cause makes shock a probability, let the surgeon use the "ounce of prevention" by *striking first.*

Of course we should endeavor to build up the patient's vital resistance by all means in our power. Where weakness from a constitutional dyscrasia or from any removable cause exists, the indication for a preparatory line of treatment is plain. In most cases it is also well to exhibit strychnine in moderate doses for several days before a major operation, thereby invigorating the nervous system. But the chief reliance, the one which is already working

wonders in the hands of those who know how to use it, is the free use of intravenous, hot, saline infusion, injected while the patient is still upon the operating table and asleep from the anesthetic, in cases where the advent of shock, otherwise, seems a probability.

The use of saline solution to treat a patient already collapsed from shock is not a new thing. Neither is it a brilliant success, because nothing is when severe shock has actually arrived. Some text-books mention it with dubious praise, others almost or quite ignore it. But the thing which is my own suggestion (so far as a study of the "Index Medicus" and the New York Academy of Medicine Library enables me to judge) is the use of this great weapon for good at the right time, and the right temperature.

This plan for the *prevention* of shock has been in use in my clinic since the autumn of 1891, as a consequence of conclusions reached after several months of experimental work upon dogs with hot and cold vascular saline infusion after bleeding, testing intra-arterial pressures at differing temperatures of the injected fluid with the kymograph and mercurial manometer, under the kind supervision of Professor Curtis in the Columbia University Physiological Laboratory during the winter and spring of 1890–91. So far as I have seen printed evidence, other surgeons did not until later adopt this plan in prevention of shock,[1] and it is commonly ignored even to-day by the bulk of the profession.

(1) Dr. F. Lange did, however, in 1888, advocate diluted claret by rectum to prevent shock where a very bloody operation was anticipated; and Drs. Weir, Tiffany and others in the discussion approved of water in this way. ("Trans. Am. Surg. Asso.," vol. iv, p. 540, *et seq*).

In evidence of priority is submitted a brief quotation from the writer's paper read before the Surgical Section of the New York Academy of Medicine, November 9, 1891, and published in the *Medical Record*, January 2, 1892: "Whosoever has noted the vigor with which unstriped muscle everywhere reacts to the use of heat—for example, the much stronger and decidedly more permanent uterine contractions which result from hot post-partum injections as contrasted with cold ones—must believe it probable that such unstriped muscle, forming as it does a most important tunic of the bloodvessels, would be greatly aided by hot saline infusion in regaining its lost tone. Perhaps, too, the central sympathetic centers would feel and respond to this stimulus. Now, since a more vigorous cardiac action (for the heart, though striated muscle, responds to the heat), accompanied by a somewhat restored vascular tone, would go far toward recovery both from hemorrhage and its attendant shock, I have felt that the experiment was well worth trying. (I had tried it as a preventive of shock upon dogs only, before the paper was written.)

Again a quotation from the writer's article in the *Medical Record* for November 12, 1892: "And why would it not be well at the end of any and every operation grave enough to make shock a probable result (though because of the ether, not as yet at hand) to inject subcutaneously (*i.e.*, intravascularly) a quart or two of hot salt water? It would be painless, the patient not yet being out of anesthesia. It would certainly be harmless. And I believe it would do much to *prevent*, by maintaining filled blood vessels, otherwise fatal shock from developing. *It seems not improbable that we shall ultimately see this*

done as a matter of routine after all severe operations." At that early date the writer had tried the method in but very few instances to prevent shock, using a half liter or more within the vessel and as much more in the cellular tissues; and could not, of course, speak as all can to-day who have used it properly, with absolute certainty as to its value upon human patients.

In this connection five points deserve especial consideration: (*a*) the place of entrance, (*b*) the proper solution, (*c*) the proper temperature of that solution, (*d*) the proper amount, and (*e*) the speed of introduction.

(*a*) In most cases the median basilic vein is chosen for the canula. Occasionally a vein in the operating wound will do. The writer demonstrated some years ago that if one is caught short of tools—has no scalpel, no canula, no dissecting forceps nor retractors at hand—the saline infusion can safely be made to enter the common femoral artery (which, being large enough to admit a lead-pencil, can always be felt pulsating if the patient still lives) by aid of a hypodermic needle attached to a Davidson syringe or a fountain syringe.[1] Kemp's method of needling a superficial vein is also a simple and rapid one; but if only the femoral artery can still easily be felt pulsating, even cording the arm may not make a vein swell.

We must not neglect to mention that the rectal route is an excellent one. The effect of the heat of the water introduced into the colon, upon the heart and the vascular pressure, is prompt and valuable. Since, however, it has been proven (see p. 32 of this

(1) For details, again discussed, as to this emergency method see *Medical Record*, December 10, 1898.

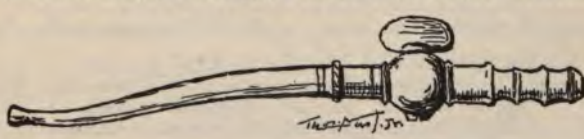
book) that it requires about twenty minutes for actual exosmosis of the saline solution into the vessels to occur in any large degree, it is evident that if the patient's condition be critical enough to make the need of preventing shock an urgent one, intravascular infusion is preferable—though the rectal plan might serve to hold the heart in good action, for a little time, by its heat alone. Even during the operation the maintainence of a full large bowel by means of Kemp's rectal irrigator can only be of benefit, and is additionally a means of safeguard against dangerous chloroform narcosis—by maintaining filled vessels. And after the patient is removed to bed it is commonly wise (in order to continue the good effects of the intravascular infusion until the danger-point is well past) in bad cases to give the hot colonic irrigation alternately an hour on and an hour off, for perhaps a half day. It is a good plan to direct that the patient drink an abundance of water or watery fluids for a day or two prior to a severe operation. This is a safeguard by promoting well-filled vessels, and is a comfort by lessening post-operative thirst.

When, following confinement, the accoucheur has a partly exsanguinated patient, he adds wonderfully to her comfort if he injects high up a couple of liters of very hot salt water by rectum. It is instructive to note that, as a rule, not a drop of the amount thus poured into the colon will be seen again. It is taken up greedily by the thirsty blood. In an emergency elevating the foot of the bed upon a high chair, and pouring in the salt water through an ordinary tin funnel inserted in the anus, suffices. If the loss of blood has been extreme, intravascular infusion should also be employed, for the condition of the bowel-wall

and of the refuse material coating it, may, at times, have an adverse effect upon ready exosmosis of the salt water from the intestine, rendering this route perhaps less trustworthy. This is true of the simple enema, but not of continuous enteroclysis, which cleanses.

As to hypodermoclysis, it is the slowest of all methods. The lymphatics are not very speedy in per mitting the diffusion of water entering the connective tissues. Also, if the proper amount, 1½ to 2 liters, is so introduced, it means quite a number of punctures, painful the next day. Again the proper bulk of fluid causes such tension of the tissues that at 120° F. (the best to prevent shock) there is some little risk of sloughing. Plainly, therefore, this route is a less desirable one than others against shock. Hypodermoclysis is the slowest method in shock, on account of the poor gen eral circulation, but the second method in speed under ordinary conditions. Combined with enteroclysis it is, of course, of greater value in shock than alone. (See hypodermoclysis in shock).

To prevent shock, then, I advocate other routes in preference to this. Upon its special value at times in choleraic infant diarrhea I have heretofore written.*



INFUSION CANULA WITH BULBOUS TIP.

(*b*). The fluid used should be the so-called normal, really decinormal, salt solution, which is 6 parts of

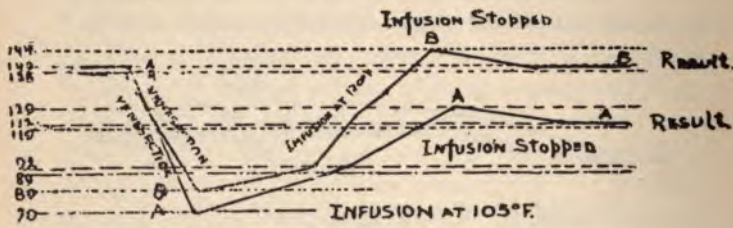
* *Medical Record*, Nov. 12, 1892; also December 10, 1898.

common table salt per thousand, boiled and filtered; roughly, a heaped teaspoonful to the liter or quart. For further details see chapter on anesthesia.

(*c*) The proper temperature for the injection fluid is *as hot as the hand can bear*, and this is 120° F. or 49° C. (See Chapter on Infusion.)

FIG. LXII.

Comparative Tracings Following Infusion at 105° and 120° F.



DOG A - NORMAL PRESSUE 140 MM
VENESECTION OF 22 cc. of BLOOD.
AND RESULTING PRESSURE 70 MM
INFUSION AT 105° F

See pages 195, 196.

(*d*) The proper amount of the injection fluid may be set down, for the adult, as never less than a liter, often two liters, and occasionally, perhaps even three liters, injecting always very slowly. To give a half-liter or less is, for the prevention of shock, almost valueless. The limit of safety as to large quantities has not as yet been very exactly formulated. The kidneys readily remove any water from the blood in excess of its needs. Should they be diseased, a less amount must of course be employed than otherwise. When these are inactive I have known in a few instances a brief watery diarrhea to carry away the excess.

(*e*) The time occupied in introducing the fluid into a vein should never be less than ten minutes per liter. To be sure, I have seen it caused to flow with double this speed and without ill effect; but, on the other hand, a temporary period of threatening heart-failure due to this cause—a rapid overstimulation—has been at times observed.

Of late we have all noticed in the journals that a few enthusiastic friends of this plan of preventing shock, by saline infusion, are using it at the *beginning* of the operation—before even a drop of blood has been lost, or any strain whatever put upon the nerve centers. If this were only done by the plan of keeping the large bowel full of hot salt water, I should find no fault, for here the blood will to some extent take up water only as it needs it. But I doubt the wisdom of the preliminary distention of vessels by intravenous infusion; for one reason, because it is plain that by such a practice we add to the amount of blood lost. For every spurting point will, from increased pressure, bleed much more furiously before it can be caught than otherwise it would do.

Just a word as to the repetition of the dose. Many times I have read of surgeons using it once in a given case and reporting a temporary good effect, but that subsequently the patient died of shock. Now, of course, no method can save all case of every dangerous disease; but common sense would teach us that if a dose obviously does good it should be repeated, and this so long as the same indications call for it. From this it does not follow that we must open a vein again and again. The rectal hot saline douche will, if rightly used, give approximately as good results for such purposes. The bed should always have its foot elevated very high, and this should remain so until danger of shock is well past. This position maintains a better supply of blood to both brain and heart, and also helps in the retention of the fluid in the large bowel. Alternately an hour on and an hour cff seems to produce more desirable results than a steady maintenance of the flow through Kemp's tube.* I think it wise not to consider the patient past his danger until the pulse becomes as low, at least, as 120 per minute, and shows no tendency to occasional increase above this number.

Thus far I have discussed the prevention of shock but have said nothing as to its treatment when actually developed and threatening the patient's life. Concerning this last, I have little to say, and that is not new. If we are called to an accident case and

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* Here it is well to note that the nurse should be instructed to begin by causing a couple of liters to run into the rectum before permitting the continuous in-and-out flow to occur. Otherwise the patient receives deceptively little. Even though there be complete incontinence of the bowel, by means of a perineal pad and double-current method, a continuous enema at 120° F. can be kept in the bowel.

find the victim in collapse, which is another name for shock, hot saline infusion is worth trying—but with small hope. Strychnine hypodermatically is probably, when used freely, our best reliance. Some surgeons use it even to the point of producing slight spasms—if the shock does not yield earlier. Hot applications about the person are essential—elevation of the foot of the bed, a help; oxygen is also of value as a respiratory and cardiac stimulant. But two prominent "dont's" should never be forgotten, namely, *don't* over-stimulate the heart, and *don't* give a particle of food by mouth, nor any medicine even remotely capable of causing nausea.

If the pulse come down to anything like reasonably safe numbers, as discussed a minute ago, let well enough alone; for if that tired heart be over-whipped it is likely to quit work. And as for the second *don't*, what is nausea in all of its symptoms but one type of shock? There is the cold, pale, wet skin, the weak pulse, the sensation of vital collapse; and no one should take the least risk of adding this, if not already present, to the surgical shock."

The duration of shock is not many hours, as a rule, as to its worse phase. Certainly it is not so prolonged but that the patient may easily have his strength sustained during this period without using his stomach, by nutrient enemata, or hot coffee by the same route, etc. And any needful remedies which might otherwise possibly nauseate can surely also be administered in the same way, or, better still, by needle. I dwell upon this matter because one so regularly sees this "*don't*" neglected, to the patient's detriment.

Two questions of utmost gravity are: whether to amputate during shock? and what relation does anesthesia bear to this problem?

As prominent and experienced a surgeon as any in this city recently remarked that he had never yet performed a hip joint amputation for an injury. Of course, if the limb hung only by loose shreds of flesh, that was another matter, and these were quickly divided. But where a formal amputation was needed he had found his patient invariably in grave shock from the injury, and in his opinion "hip joint amputation is a poor way to treat shock." He had cleansed wounds, applied sterile gauze and splints with all speed, and with as little disturbance to the patient as possible, and had endeavored to strengthen in every way the nervous system to meet the amputation later. But in every instance of such extreme injury death had quickly followed, notwithstanding, and he could not believe that amputation would have prevented it.

This matter is a moot point—the question whether or not to amputate without delay, upon finding an injury which must necessitate this, either then or later. The opinion herein stated is shared by the author. It also upholds a practice which is now becoming more prevalent, and wisely so—that of awaiting events for twenty-four hours or thereabouts, to be sure that a limb though horribly mangled may not survive, at least in a portion of its length. Experience has taught me that wonders sometimes happen in this regard. The single prick of a dirty pin or sliver may prove of more real peril than great wounds, mangling the flesh hideously, yet not badly fouled.

In cases of doubt—that is, where operation of some severe sort would appear almost imperative, and where shock seems not especially grave, we may perhaps try the "anesthesia test." This is the

exhibition, very cautiously, of ether inhalation, meanwhile watching its effect. If, after the first few breaths of it, the pulse and respiration improve, then it is probably safe to operate. That is, it is simply thus shown that the nervous centers are not on the verge of dissolution.

If on the contrary the pulse and respiration are made worse in character, stop; for otherwise the patient will the more quickly die.

This is a reminder, too, that general anesthesia is itself, if at all pushed, or prolonged, distinctly at times a means of adding to shock already present.

The author does not, consequently, advocate the "ether test" being carried further than the briefest anesthesia even ln the cases pronounced operable thereby. It may be safely asserted that where an operation of any length is essential, under such adverse conditions of shock, *general* anesthesia should be avoided—provided the patient be mentally lethargic, and hence not to be frightened by the preparations and surgical paraphernalia; and that such very moderate degree of pain as the patient in this "torpid" state can feel should be prevented, not by major but by minor (local) anesthetics, such as installation of a very weak cocaine or eucaine solution, for example.

ANESTHESIA AND ITS RELATIONS TO SHOCK.

CHAPTER XII.

I.—GENERAL CONSIDERATIONS UPON MAJOR ANESTHESIA.

II.—THREATENED DEATH DURING MAJOR ANESTHESIA.

By Robert H. M. Dawbarn, M.D.,

Which shall we use—ether or chloroform? There is no study less profitable than that of the relative death percentages all over the world from chloroform *vs.* ether. It is absolutely wasted time. That von Nussbaum saw chloroform used 40,000 times without a death,* and that chloroform had been exhibited 36,500 times in the Edinburgh Infirmary with but one fatal result,† would seem evidence that such danger from the use of this anesthetic, as exists, is largely due to the personal equation; that is, to inexperience on the part of the anesthetist, or to improper methods of meeting the emergency. Whereas in studying 12,000 cases operated upon in New York Hospital, Dr. Weir found ether-deaths in the proportion of 1 to each 2,000.‡

* Wood's Reference Handbook, Vol. 1, p. 189.

† *American Journal of Medical Sciences*, November, 1886.

‡ *Trans. Am. Surg. Assn.*, Vol. vi., p. 544.

In New York, Philadelphia, and Boston there is a curious distrust of chloroform not apparent in the rest of the world of surgery to the same degree, either abroad or in this country.

The writer was one of a hundred or more auditors when that famous surgeon, Dr. Henry B. Sands, once told a story, which it required a man of his eminence and his truthfulness to relate, concerning an experience of his in Germany. He was present during an operation by Dr. Schede, in the Allgemeines Krankenhaus, in Hamburg-Eppendorf, when Schede happened to remark that he had never in his life seen ether given; that he and all the famous men of his country relied solely upon chloroform. Dr. Sands thereupon agreed to enlighten his inexperience, and taking the anesthetist's place gave ether to the next patient. It is painful to state that this patient had the bad taste to die from the ether, thus casting discredit upon a most valuable drug. Dr. Sands said that he and Dr. Schede worked over the man with artificial respiration and other means for a long while, but failed to revive him. And I venture to say that Dr. Schede has now the same distrust and fear of ether as an anesthetic which seems to prevail regarding chloroform in the trinity of cities just named.

If it be admitted that, taking averages the world over, more deaths on the table occur from chloroform than from ether, nevertheless were we to add those happening weeks and months later, due to ether irritation of lungs or kidneys in persons already enfeebled in these organs, perhaps the percentages would be different.

It is unquestionably true that more skill is needed to give chloroform safely than ether. Were the

writer to need an operation upon himself he would choose ether, if subjected to an "emergency" anesthetist, but chloroform if that assistant were skilled and experienced.

Even in the three cities just mentioned together, however, certain conditions are recognized as justifying the use of chloroform as against ether. These are:—

1. The presence of severe pain. Chloroform is relatively safe in childbirth, even in the hands of inexperience.* The reason is, perhaps, that the suffering causes cerebral congestion to some degree, and with plenty of blood in the brain chloroform is safer than otherwise.

2. In childhood; at least, this is the teaching of Dr. Jacobi and numerous other children's specialists.

3. To control convulsions—uremic, epileptic, strychnic *et al.* Here ether would be too slow in taking effect.

4. In cases where actual cautery must be used about the mouth, ether being inflammable.

5. In certain diseases of the lungs, kidneys, stomach, brain.

6. In military surgery, being less bulky, more rapid in action, and cheaper.

7. In hot climates (ether boils at 95° F., chloroform at 142° F.

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* H. C. Wood says (*Therapeutics*, 7th edition, p. 150): "So far as I know, no death has yet occurred from chloroform during parturition."

Wood's Reference Handbook, Vol. 1, p. 195: "Chloroform has been used in natural labor many hundreds of thousands of times, yet but a single case of death is on record where it was administered by a competent medical man, and in this instance there is lack of post-mortem confirmation."

8. At night, if flame must be held near the patient. (But chloroform is not free from disadvantage at night, being decomposed by the flame, and chlorine and other gaseous irritants set free. All surgeons have noticed the tendency to cough under such circumstances).

The Question of Mixtures.—This is one that remains unsettled, the widest divergence of views continuing. Dr. J. C. Reeve, already quoted as to relative mortality, says: "The chloroform committee of the Medico-Chirurgical Society of London in 1864 recommended, among others, a mixture of one part alcohol, two parts chloroform, and three parts ether, by measure, known as the 'A.C.E. mixture,' which has probably been used more than any other. At Vienna a mixture of six parts of ether to one of chloroform has been used so much as to be known as the 'Vienna mixture.' It is stated that there have been eight thousand administrations of it without a death. Billroth, of the same city, used a mixture of three parts of chloroform, one of ether, and one of alcohol."

Against such mixtures the argument has always been urged that a new chemical is not thus made, with a single rate of diffusion: and that while the rate of relative evaporation is doubtless in part modified by the mixture, the patient substantially gets first ether, then chloroform, then alcohol, in order of volatility*. The writer agrees with the majority of surgeons in feeling that a gain in security is not made thereby.

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* See "Further Experimental Researches on the Effects of Different Anesthetics on the kidneys (*N. Y. Med. Jour.*, Nov. 18–25 and Dec. 2, 1899, also in Therapeutic Addenda.

Chloride of Methylene. CH_2 Cl_2).—This is mentioned simply as standing as a type of drugs belonging more or less to the chloroform class—the halogen anesthetics. This short essay does not permit of a careful discussion of them. This particular one enjoys the endorsement of Sir Spencer Wells, who after considerable use of it, regards it as the best anesthetic.

Nitrous Oxide.—The writer believes that laughing-gas will be considerably more used in the future, in general surgery, than in the past. Now that it is obtainable in liquid form in small steel canisters* of such a size that one may be slipped within a small handbag, an objection to its use has disappeared. A special closely fitted mask and a large thin rubber bag to hold the gas generated from the liquid, complete the outfit.

Heretofore its exhibition has remained almost solely in the hands of dentists; but it would seem that there is a field here for young physicians to fill. The writer has many times employed a certain dentist to give gas at the patient's house, and on more than one occasion the operation has lasted, with satisfactory anesthesia, fully three-quarters of an hour.†

As every one knows, the color of the patient

* It is liquefied by about forty atmospheres. Since 1860, or thereabouts, N_2O has been liquefied and shipped in large canisters all over the world. But in general surgery at the patient's residence, there has, as yet, been comparatively little use of the small, easily portable steel cylinders of the liquid.

† Prof. R. Ogden Doremus informs the writer that many years ago at a lecture at Steinway Hall, New York, for the benefit of the widow of Dr. Horace Wells, Dr. J. Marion Sims stated that he (Sims) had performed an operation an hour and twenty minutes long under laughing-gas anesthesia.

meanwhile is always ghastly in its lividity; but this seems not dangerous in realty. Differing or chloroform, should alarming symptoms appear, removal of the inhaler is followed by instant improvement—almost with the first breath of air inhaled. Of course some little skill is needed to keep the patient from waking repeatedly during an operation of some length, but it is certain that the experience and the care need not be more than for the safe use of chloroform. It is a pleasure to see the absence of the initial choking and struggling and of subsequent anorexia and nausea with these patients; and certain ones who would refuse a needed operation, because of the ether or chloroform, will agree readily to take laughing-gas.

Due largely to the investigations of Dr. Paul Bert, of Paris, as to exhibition of nitrous oxide with oxygen, we know that it has anesthetic qualities aside from merely depriving the patient of oxygen. And the addition of oxygen, by removing the lividity alluded to, seems desirable.* Dr. W. W. Van

*Nitrous oxide and oxygen can now be administered in combination by Hewett's apparatus. These are contained in separate steel canisters (the oxygen, however, in compressed gaseous, not in fluid form), manipulated by foot power, conducted thence to a soft bag divided into separate compartments, and from this by separate tubes to a common tube. At their common point of entry is a valve arrangement by which the quantity of the respective gases admitted to the common tube can be accurately regulated, so that nitrous oxide or oxygen can be given separately or in combination of definite percentages, The usual N_2O face mask is fitted to the receiving tube.

In an elderly or full-blooded patient nitroglycerin, gr. 1-100, by hypodermic injection should be given previous to such anesthesia and repeated if indicated (Kemp).

During the past few years the writer has habitually anes-

Arsdale has shown that the best proportion would seem to be 10 per cent. of oxygen to 90 per cent. of the N_2O—with a tight face-mask, and pressure, as from a heavy book, upon the gas-bag. He also noted that, with this addition of oxygen, men and alcoholics of both sexes do not so readily succumb to the anesthesia as do women and non-alcoholic subjects.*

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thetized for long operations with laughing-gas, and then switched to ether. By using the ether inhaler with bag hereinafter described, and the bag being afterwards filled with N_2O, the change is smoothly accomplished, and there is no real need to invest in the above expensive apparatus. This plea does away with the unpleasant features attending the beginning of ether anesthesia, and proves entirely safe.

It is considered unwise to shift from gas DIRECTLY to chloroform.

Because of the partial asphyxia caused by the gas, the heart is temporarily somewhat embarrassed; and from the same reason the breathing is tumultuous. These conditions are the reverse of those which are desirable in the beginning of a chloroform anesthesia. Therefore, if such a shift be desired, let the change be made from gas to ether, and after a few minutes from the latter to chloroform.

*It would seem an obvious advantage and great convenience if the laughing-gas mingled with 10 per cent. of oxygen could be liquefied together and supplied from the same canister to the patient. This is not feasible, however. Oxygen requires 300 atmospheres (more than two tons to the square inch) plus the most intense cold to make it liquid, and would hardly be safe in a portable canister. Laughing-gas needs but 40 atmospheres for liquefaction, as stated heretofore.

Nitrous oxide is a high tension pulse anesthetic, chloroform lowers tension. The danger of the sudden substitution of the latter for the former is therefore obvious. It would cause at once- sudden dilitation of the vessels (See Hare on chlorform), also similar to shock. Two deaths attributed to to N_2O., can be so explained as this method was followed. —*Thomson and Kemp.*

The kind of inhaler to be used for ether and for choloform is a matter of no little importance. With chloroform the safest proportion is estimated at

FIG. LXIII.

Improved Chloroform Inhaler—Modified from Esmarch's.

from 3 to 4 per cent. of it mingled with the inspired air. Clover's apparatus permits of such accuracy, but is very expensive. In practice we find that Esmarch's inhaler is safe, and it is the one most used everywhere. (See figure.) This device per-

mits of abundant admixture of air. The chloroform should for safety be poured on from a drop-bottle, a minim at a time. The improved Esmarch inhaler shown in the illustration allows instant change of the flannel or gauze or cotton-wadding cover, for each new patient—a decided gain in cleanliness. The cover is sure to be soiled to some extent whenever used, because (if for no other reason) of the oil or vaseline with which the patient's face should be smeared, to prevent a dermatitis due to the irritant chloroform vapor. In use, the covering material is laid upon the frame, over this the wire rim is snapped into place, and any excess of the covering is trimmed away with scissors.

As to ether inhalers upon the market, their number is considerable. Perhaps, however the familiar towel-and-newspaper cone of home manufacture is still the favorite with the bulk of the profession. It has at least the merit of cleanliness, for the same

FIG. LXIV.

Chloroform drop-bottle. It is always safest to give the drug drop by drop in this way. An ordinary 10-cent nitric acid drop-bottle, will, however, do as well. It is now obtainable almost everywhere.

FIG. LXV.

FIG. LXVI.

The author's ether inhaler. The upper figure shows the cage removed and filled with gauze. (The air-bag is relatively much more capacious than is herein illustrated).

cone is seldom used twice. Still, with ether quoted at upwards of a dollar a pound, and the ordinary estimate being a pound for each hour of anesthesia, it is plain that the device is an expensive one.

Allis' inhaler has been used to an enormous extent, and need not be described. It also is wasteful of ether, and as it is rather bothersome (though the latest make is improved in this regard) to remove the old and replace by new the numerous folds of bandage on which the ether is poured, too often we see these inhalers, though soiled by sputum and other ejecta, continued for some time in use upon successive patients.

The ether-inhaler figured herein (see figure) was devised by the writer some ten years ago, and has since been continually used at his clinic and in private practice.

Several years ago Dr. F. H. Wiggin, gynecologist to the New York City Hospital, wrote a commendatory article upon it after using it for some time. It has been in regular use at that hospital almost ever since it was first invented, and is so still. It is made by F. A. Reichardt & Co. of 27 Barclay street, this city, to whom the author feels indebted for the ingenuity and painstaking care which have so improved upon the original suggestion.

Its advantages are (*a*) economy, and (*b*) ease of cleansing, as well as (*c*) those benefits and added safety to the patient resulting from avoidance of saturation of all his tissues by a great excess of ether. The apparatus is upon the same principle as the well-known one of Clover, but is less complicated and less expensive.

(*a*) As to economy, the thing will pay for itself, in saving of ether, after a very few long operations. It is literally true that only one-fourth to one-fifth as much ether is needed as with a home made cone;

indeed, not much more of ether than one uses of chloroform in an equally long operation, provided a skilled anæsthetist is in charge. Also it is simple and durable, and should last for years.

(*b*) The stout open cage of aluminum fitting within the solid outer frame receives a little gauze, or absorbent cotton, or a small handkerchief. On this the ether is poured. At the end of the operation the the cage is removed, emptied, and held beneath the hot water faucet for a moment, when it is clean and ready for the next case.

The face-piece of stout rubber of course is removable for washing, as is the air-bag. This latter is a light, thin rubber bag, *of a capacity considerably greater than that of the lungs*, which is an important point. The solid rubber face-piece is more durable and simpler than are the pneumatic ones seen on certain other inhalers, and fits the face quite closely enough. To avoid one more contrivance demanding cleansing, no device is used (as with the Clover and the Ormsby, for instance) for pouring in ether without removal from the face. In this inhaler, just as with the home-made cone, when more ether is needed the cone is removed long enough—a few seconds only—to receive it.

(*c*) Under this heading the reader will observe that because of the air-bag attachment the ether is rebreathed again and again. This, of course, economizes ether, but what is more important, it saves surcharging the blood, and the lungs, kidneys and other viscera.* The ether thus warmed is also, be-

* Thomson & Kemp's investigations show that the deleterious effects of the ether on the kidneys depends on the amount of the anesthetic and the method of its administration, and that the question of the proper cone is of grave importance. They consider that the Dawbarn inhaler fulfils the proper indications.

cause of that warming, less apt to cause an ether-pneumonia; continued evaporation of ether being very chilling, as everyone knows. Since much less ether is given, it follows that the danger of death from ether-narcosis is lessened. It is surprising to one accustomed to the home-made cone to see how quickly the patient recovers entire consciousness; and whereas by the former device the breath remains redolent of ether for nearly twenty-four hours, and for the same reason the anorexia is long continued, by the use of the inhaler we are discussing the elimination is completed and the patient's appetite has returned in much less time.

Because of rebreathing the same air, a CO_2 anesthesia is superadded to that from the ether, and consequently the patient is almost as quickly anesthetized and with as little struggling as if from chloroform. To the writer this seems one of the distinct advantages of the Clover air-bag principle, and he would differ from those who consider the CO_2 an objection.* It is, of course, easy to observe the color of the skin or mucous membranes, and if more oxygen is desired, to hold the cone less tightly to the face, permitting at any time an admixture of air. The present writer considers, in conclusion, the use of the large rubber bag in ether anesthetizing as being from every standpoint a wise measure; and that the Allis, the towel-and-newspaper, and similar devices are comparatively unsafe.

THREATENED DEATH DURING MAJOR ANESTHESIA.

There are two surgical emergencies so appalling

* See in corroboration of this view several experiments quoted in Wood's *Therapeutics*, 7th edition, p. 135, showing that a carbonic acid anesthesia is a safe one.

in their character, and so quickly fatal if not promptly met, that they may be said to transcend in importance all others. These are, anesthesia-narcosis threatening death, and unexpected hæmorrhage upon the operating table.

In each of these the safety of the patient demands that the surgeon shall have his knowledge at his finger-tips, and be ready instantly and almost automatically to do the right thing.

The first of these is the topic under discussion in this paper; and no one will demur to the statement that it is the duty of every doctor to memorize the measures to meet this indication until they are as familiar to him as is the alphabet. For no time will be left to him for debate when confronted by the actual fact. Every moment is then golden, and indecision equally with unwise choice may cost a life.

PREVENTION.

Prevention is half the battle. If the suggestions under this heading are heeded, few indeed will be the actual cases encountered.

The writer makes it an almost invariable rule, and has done so for many years, to precede every exhibition of either chloroform or ether by a hypodermatic injection of morphine sulphate guarded by atropine sulphate; in the adult from gr. $\frac{1}{6}$—gr. $\frac{1}{8}$ of the former, and from gr. $\frac{1}{150}$ to gr, $\frac{1}{200}$ of the latter; allowing, say, an hour for it to take effect. Also as a rule, an ounce or more of whisky or brandy is given at the same time by mouth.

There are several reasons for this course, but one alone should suffice; namely, that all of these drugs are analgesics, and that consequently much less of

the anesthetic need be inhaled, and the danger of death is to just that extent lessened.

Indeed, if any reason exists why neither chloroform nor ether nor laughing-gas should be taken, a fairly comfortable operation is possible by free use of these means alone, as all surgeons know.

Again, nearly 50 per cent. of all deaths from $CHCl_3$ have occurred before complete anesthesia was accomplished; commonly within the first minute or two of its exhibition, and when only a very little had as yet been used.* Had the stage of excitement and of fright been prevented by a little morphine, atropine and whiskey, with their calmative and steadying influence on the reflexes, this mortality would probably have been avoided.

It will be noted that all three of the aids mentioned (morphine, atropine, alcohol) are heart-tonics when used in moderation, and tend also to diminish the likelihood operative shock; and further, that atropine is one of our best vaso-motor stimulants.

(For all the reasons mentioned in the last sentence the writer approves of the use of strychnine sulphate, in small doses, for a few days prior to any severe operation. Perhaps, when shock is actually present, it is of more value than any other one drug; and if this be true, its use in *prevention* of shock would seem sensible.

Dr. H. C. Wood has demonstrated the value of strychnine when used by needle in treating anesthesia-narcosis; and here again its use in *prevention* seems sometimes indicated. The present writer

* As a hypodermatic injection of gr. 1/30 or gr. 1/20 of the other preparatory means named, an hour

* Ref. Handbook, *Anesthetics*, Vol. 1, p. 190.

before major anesthesia, if the heart is found either rapid, irregular, or weak in action.)

Although we approve of the use of alcohol *prior* to anesthesia, as just stated, because then less of the anesthetic will be needed, a clear distinction must here be drawn between this fact and its exhibition as a remedy *where death is actually threatening from au excess of ether or chloroform.* This distinction must not be forgotten.

The writer has witnessed again and again instances of the accident under discussion, in which the operator and his assistants endeavored by numerous hypodermatic injections of whiskey or brandy—narcotics—to revive a patient suffering from an excess of another narcotic. Dr. H. C. Wood has used the strong language to characterize this procedere, that "it is little better than murder!" To be sure, alcohol is a heart-tonic, but we have other equally swift heart-tonics which do *not* tend to deepen the deadly narcosis.

Rather recently the cocainization of the nares and larynx by a weak spray, just prior to anesthesia, has been considerably used. It certainly renders the inhalation less unpleasant, and in the case of chloroform may quite conceivably prevent danger. We know that very early in a chloroform-anesthesia a certain danger sometimes exists that this irritant drug may cause a reflex action whereby the pneumogastric nerve stops the heart—and it may not wake up again.*

Quite a little work has lately been done by various surgeons regarding anesthesia by ether mixed with

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* The suggestions in the opening paragraphs under *prevention* form an effective safeguard against this danger.

oxygen. It would seem that the idea may be of value in helping to avoid narcosis in excess. It has not, however, come into general use. It is a revival, in principle at least, of the "ozonic ether" of Dr. Richardson, who advised this for anesthesia before the Brit. Med. Association in 1865. He produced this compound by agitating a 30 volume solution of peroxide of hydrogen with anhydrous ether, and adding 5 per cent. of alcohol.

Under the heading of Prevention we must remember not to begin cutting until the patient is "under to the surgical degree." Buxton, Reeve and other writers upon anesthetics have pointed out the surprisingly large proportion of cases in which incomplete anesthesia, by lowering vital functions, has permitted fatal shock to result from trivial though painful operations, such as strabismus, tooth-extracting, circumcision, etc. Indeed, it is estimated that 40 per cent. of chloroform deaths have been in cases of such a trifling nature, and there seems no other adequate explanation of so large a proportion in comparison with deaths during major operations.

Again, in reference to chloroform, it is probably safer to tip the table so as to have the head a trifle lower than the feet; this as a measure of precaution, and for reasons to be more fully discussed later, under the heading of *treatment*. But the patient may be permitted to choose whether to lie upon the back or the side during the inhalation. Many are the recorded cases of death from chloroform exhibited in the sitting or the half-reclining postures; which invite anemia of the vital centres. Dr. H. A. Hare has recently pointed out the fact that chloroform kills really by vaso-motor paralysis,

whereby "the man is suddenly bled into his own veins and capillaries, as effectively as if into a bowl;" and instant anemia of brain and heart results.*

It is the part of wisdom to insist upon twenty-four hours, at least, in hospital (preferably) and in bed, before anesthesia. Bodily rest, and time in which the mind may grow accustomed to the new environment, are of obvious value.

Arule, which should be inflexible, requires the cautious surgeon to make a physical examination of his patient's various organs shortly before operating. Notably, the kidneys must not be neglected. Presence of albumen should interdict the use of ether. It is believed that those with impaired renal function are more apt than others to succumb to the narcosis. Certain surgeons, and especially Dr. R. F. Weir, consider chloroform at least equally an irritant to the kidneys. Here we surely have an indication for the employment of nitrous oxide anesthesia.†

If any faintness be noted due to the preparatory fasting which we must enforce, nothing

* Under *prevention* Dr. R. C. Kemp's recent ingenious suggestion deserves mention: this is to use rectal flushing by hot salt-water with his double current tube, during the whole operation; thereby maintaining filled blood-vessels, and inducing a stronger heart-action.

† We believe nitrous oxide least irritating to the kidneys, chloroform a close second in this regard, and ether the most irritating—especially in case no air-bag is used. Mixtures of the anethesics are of no advantage. The nitrous oxide administered with oxygen would be the superior method to employ, but requires an expensive and rather complex apparatus.

NOTE.—Experiments by Drs. Thomson and Kemp, entitled "Further Experimental Researches on the Effects of Different Anesthetics on the Kidneys," *N. Y. Medical Journal*, Nov. 18, 25 and Dec. 2, 1899. Read before the N. Y. Academy of Medicine, May 18, 1899. An abstract of this paper will be found under "Therapeutic Addenda," in this volume.

but benefit can result from a nutrient enema an hour or so before the operation. This may also contain whiskey or brandy if desired, and is a good way in which to exhibit the alcohol which we have advised for routine use, in *preparation* for anesthesia.

Perhaps it is a waste of words to mention that the bowels and bladder must have been recently evacuated; and that it is a duty of the anesthetist to see that corsets and all tight clothing are removed, also artificial teeth. Let the inhalation be most gradually commenced; it is always a mistake to force a sudden unconsciousness. A good anesthetizer should try to encourage and calm his subject, and to divert his thoughts; and should chat quietly but cheerily and reassuringly with the patient while begining the administration, and even until he sinks beyond subconscious anxieties. He may even be allowed, at first, to hold the cone in his own hands if desired. These apparently trivial points have a real value in allaying fright, which is dangerous; and they must not be ignored.

The advantages herein of the unirritating, tasteless, odorless laughing-gas as the first step to ether have already been alluded to.

(The beginner should be taught that the palpebral reflex is practically as good a guide as the conjunctival. There is no junstification for the subsequent sore eyes due to frequent rubbing of the cornea or conjunctiva, so often to be noted.)

The writer considers stertorous respiration—which is due to paralysis of the *velum pendulum palati*, from deep anesthesia—a sufficient indication, as a rule though not invariably, for permitting inhalation of a larger proportion of air. To keep the

patient snoring heavily through a long operation, is to subject him to a nearer approach to a lethal dose than the writer deems wise, and also to invite shock.

The color of the blood is to be noted by the surgeon, and if it seems a shade too dark the anesthetist should be warned. The pupils too are a fair though not absolutely reliable guide. Should they suddenly dilate it means instant peril.*

In using a tampon-canula after tracheotomy, for exhibition of the anesthetic, let it be remembered that here especial care is needed, as it is unpleasantly easy to exclude all oxygen, and to have an asphyxiated patient in consequence.

Perhaps a word may not be amiss regarding anesthesia by the rectum. This is practicable by ether-vapor, the bottle being placed in hot water and the vapor conveyed by a rubber tube *upwards* into the rectum.† The advantage is, avoidance of the excitement, coughing and semi-strangling sometimes observed while beginning the ordinary method; also it is of use where actual cautery about the mouth or nose is contemplated. Disadvantages are, occasional causation of a severe proctitis; and also in event of excessive narcosis, the patient, although the supply be stopped, must absorb the large amount of ether-vapor filling his rectum and colon before he can begin to revive.

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* The writer disapproves the idea that a little morphine —gr. ⅛–⅙—(guarded too by atropine, which he advises) is objectionable before anesthesia because interfering with the pupillary test. Its advantages certainly outweigh this or any other conceived disadvantage; and we have numbers of other tests at hand as to depth of anesthesia.

† *Upwards*, to avoid possibility of pouring fluid ether into the bowel.

When a child is to be anesthetized, chloroform being the intended means, it is an excellent plan though infrequently used, to avoid all excitement and fright by giving it during sleep. With a moderate amount of skill this is not a difficult feat, the child gently sliding from the natural into the artificial slumber. With adult patients, however, while possible of accomplishment in occasional instances, this is not generally practicable.

And finally, under *prevention* still, we should allude to a plan, little advocated in print, but which has only to be witnessed once in order to commend itself. Namely, as a measure of precaution (in a patient of feeble vitality about to be subjected to operation), *maintaining a reserve guard of pure blood*, by accumulating it in one or more of the extremities; to be released, in event of need during narcosis.

For other purposes this temporary sequestration of blood has been employed by a number of physicians, but Dr. David Webster was the first to suggest it for this indication in 1877, in a letter to the *N. Y. Medical Journal*, and shortly thereafter the writer was the first actually so to use it.

The technique is simple. The thigh, for example, is corded at the groin; at first slightly, for a few minutes, permitting it to swell visibly from accumulated blood, and then tightly enough to obstruct all flow in either direction. This is done with a rubber bandage. The limb is now kept wrapped in a blanket, with warm bottles or bricks about it. In case of dangerous narcosis, release the band, elevate the limb, and you pour great quantities of pure blood into the body surcharged with ether or chloroform. The good results are striking and su-

pervene promptly, the patient quickly becoming conscious.

It is obvious that in an operation which will probably occupy much time this plan might not be wise; but for half an hour at least the blood can be retained without danger to the limb.*

Last, under the heading of prevention, but not least, we should mention the advisability of placing on guard at the head of the operating table only an experienced man. In almost every hospital this work is relegated to the junior assistant—in the opinion of the writer, a grave mistake. If that junior has had instead some months during which opportunity is given him to observe the proper methods as carried out in expert and experienced hands, then as senior assistant he becomes a comparatively safe man to trust.

Partly to avoid interference on the part of the operator with the skilled anesthetist, partly to insure the close and undiverted attention of the latter to his work, it is the practice in some hospitals to screen the anesthetist, and that part of the subject under his charge, from the operator and field of operation.

It is well to adopt as a standard rule the custom of having the anesthetist call out at regular intervals of, say, five minutes, the speed and quality of the patient's pulse and respiration.

Certain matters within the control of the surgeon are too often neglected: Lack of punctuality on his

* For fuller details, and a study of the other purposes for which, prior to an operation, this plan may be employed, the reader is referred to the writer's article upon Anesthesia Narcosis, in Vol. IX of Wood's Reference Handbook, and in which is quoted in full an essay by Dr. Charles McBurney upon this point.

part, and consequent mental distress of the patient awaiting operation.

Starting the anesthesia too soon before the operator is ready for the patient—perhaps before the surgeon has reached the hospital.*

Again, lengthy discussions, or lecturing instead of operating, while the patient is under the anesthetic. Also, slow operating and fussy technique. To-day we have as a class lost, or seldom cultivate, the wondrous speed and dexterity necessary before the days of ether and chloroform. This is a pity, for needless length of operation both renders the danger of anesthesia greater and is one of the chief causes of shock subsequently.

Lack of judgment in the selection of the proper anesthetic to fit the case.

Rough manipulations during the operation: For example, in operation upon the cervical lymph nodes, marked circulatory disturbances result from even moderate traction.†

Lack of attention to proper warmth of the patient during the operation.

Ignorance of the operator regarding the indications for and proper heat of saline infusion—if threatening heart failure should show the need for this.

To indicate some of the necessary duties of the anesthetist the following chart in use at the N. Y. City Hospital is appended:

* The writer knows of an instance in one of the New York hospitals where the patient was kept under anesthesia for several hours awaiting the promised advent of the surgeon. This led to an investigation, and to a change of rules whereby the surgeon must be on hand before the anesthesia is started.

† The pneumogastric and other important nerves account for this.

CITY HOSPITAL.

Service of DR. DAWBARN.

OPERATION CHART.

Name.....

Age.....*Nationality*.....

Address.....

General Physical Condition.....

Disease.....

Operator.....

Operation.....

Remarks.....

.....

.....

.....*House Surgeon*

ANESTHESIA CHART.

Just before Anesthesia.
- *Pulse*.....
- *Temperature*.....
- *Respiration*.....

At end of Anesthesia
- *Pulse*.....
- *Temperature*.....
- *Respiration*.....

Urine tested before.....

Last Food.....*Amount*.....*Time*.....

Preparatory Treatment (One hour beforehand)
- *Morphine*.....
- *Atropine*.....
- *Whiskey*.....

Anesthetic.....*Amount used*.....

Duration of Anesthesia.....

Remarks.....

.....

.....*Anesthetist*

PATIENT'S CONSENT.

I hereby consent to the above operation, fully understanding the dangers and uncertainties of the result

.....*Patient*

Though not strictly within the field of the present essay, yet it may not be amiss to add a few words as to the after-care of the stomach. From the time the ether or the chloroform is discontinued, inhalation by the still unconscious patient of the vapor of strong vinegar, poured freely upon an ordinary chloroform mask (see cut), and continued if need be for a time if he is fully conscious, will go far to prevent the nausea otherwise so common.*

In addition, occasional sips of water, as nearly scalding hot as the patient can swallow, are of much use. It is commonly wise to give for the first twenty-four hours after operation nothing whatsoever else by mouth.

TREATMENT.

Dr. H. C. Wood in his study of this subject for the Berlin Congress teaches that the treatment should be practically identical whether for ether or for chloroform-narcosis; and this is the doctrine we will follow.

Under this heading, in order to be systematic and orderly, the better to aid memorizing, let us discuss :

1. Respiratory trouble. (*a*) Obstruction to the entrance of air. (*b*) Failure of the respiratory center.

2. Heart trouble.

Of course, too, we may have to treat both conditions at the same time.

1. RESPIRATORY TROUBLE.

Under (*a*) of the first head we have to deal with dropping of the tongue back upon the larynx, caus-

* Six years ago this plan was not in use at the Dublin Rotunda, and is so still. I am unaware who originated it.

ing asphyxia; and also with obstruction from thick, ropy mucus, or blood, or pus, or vomited food inhaled.

Trouble with the tongue is commonly best met by Benjamin Howard's method of raising the epiglottis. Often this cannot be done effectively by use of tongue-forceps (though these may of course be tried), and if such traction fail to relieve the dyspnœa, the Howard position should be adopted, *by over-extending the head.* Turn it as sharply backward as possible, at the same time *closing* his mouth. You have now an almost straight passage from the nostrils to the larynx; and the tense genio- and mylo-hyoid and digastric muscles, and in turn the hyo-epiglottic ligaments, force the epiglottis to stand upright and to ward off the tongue from falling back upon the laryngeal entrance.

Instead of this plan, and somewhat less effectual, it is that of forcing the lower jaw forward by the thumbs of the anesthetizer placed behind the rami. Thereby again the above-named muscles and ligaments are made somewhat tense, also the genio-hyo-glossi muscles, and in turn the glossi-epiglottic attachments, and the epiglottis is thus lifted.

When in great haste, the tongue be drawn forward by the bent forefinger hooked well behind it in the mouth, and this effective if primitive method must not be forgotten.

Should our difficulty be with foreign matter in the pharynx and mouth, here we use sponges on long holders. Often the gag meanwhile is necessary. Vomiting implies insufficient anesthesia, and a tendency to vomit should be met promptly and prevented by pushing the anesthetic, until this reflex is ubdued.

To return for a moment to tongue forceps; it is a fact that a very stout silk seture passed vertically through the septum linguæ by aid of a needle, and used as a tractor, will prove less annoying next day in its results than the forceps, if the latter has been used at all vigorously.

One need hardly remark that the operator imperils his patient's life who does not insist upon five or six hours' prior abstinence from food. But occasionally a patient disobeys the injunction and does not confess. Then, too, we occasionally, if rarely, meet a case where from previous muscular atony of the stomach, or from obstruction at the pylorus, or from nervous gastric inactivity due to fear of the coming event, food eaten even twelve and twenty-four hours earlier is vomited during the operation.

Wiping out the pharynx by swabs on long holders is quickly done; but if the patient suddenly grows cyanotic, it probably indicates vomitus inhaled and caught by the vocal cords.

In that case, inverting and shaking the patient must promptly be tried ; or an expert with a curved laryngeal forceps guided by the left forefinger can perhaps remove the obstruction; but, if imminent suffocation compels, theoperation of laryngotomy must be performed, which takes less time than the reading of this sentence. It is a single, transverse thrust through the skin and crico-thyroid membrane; entering the air space, therefore, well below the chink of the glottis.

Under (*b*) we may try:

1. Laborde's method of rhythmic traction upon the tongue, quite vigorously, and about as frequently as the normal respiratory act.

2. Dr. W. Gill Wylie's plan, which is to seize a handful of the belly-wall, about the region of the navel, and to lift it sharply forward, away from the spinal column. At once the patient gasps, from reflex stimulation. This is repeated again and again until normal respiration is established.

3. Stretching the sphincter ani vigorously with the thumbs.

4. Ice slipped into the rectum, or rubbed against the nape of the neck.

5. Slapping the chest and abdomen with towels wet in ice water.

If the patient be "under to the surgical degree" it is plain that such methods as the foregoing, dependent as they are for success upon reflex stimulation, cannot be really effective until a portion of the anesthetic is eliminated from the blood and the reflexes return. Hence the use of:

6. Large hot saline injections, by rectum or a vein, acting more by direct effect of hotter blood upon the respiratory center than by reflex action.

7. Various methods of artificial respiration, such as Sylvester's, Hall's, Schultze's (with little children) and several more. Those just named are too well known to need description. We may say a word however, as to the technique of certain others. Kœnig's plan is intermittent pressure with both hands about the chest, one of the thumbs being placed in a space *over the heart* (differing simply in this respect from von Nussbaum's method) between the apex-beat and the sternum. And Maas' modification of Kœnig's is one whereby the pressure

aforesaid is made very rapidly (120 times a minute) instead of at the ordinary respiratory rate of speed.

All of these methods would seem to act mainly by frequent expulsion of narcotized air, and admission of fresh; though Kœnig and Maas claim for the thumb in one of the præcordial spaces a mechanical stimulant or irritant effect upon the heart, as well.

8. Insertion of a soft catheter down the larynx and trachea, and use of the operator's lungs to replace narcotized air by fresh.

9. The bellows method (Fell-O'Dwyer): A special and ingenious mechanism for removing exhausted or poisoned air, and replacing it at each stroke by an equal bulk of pure atmospheric air.

10. Inhalation of Oxygen, while efforts at respiration are being artificially maintained. Every well-equipped operating room should be supplied with a canister of oxygen, against such an emergency. We believe this to be of utmost value.

11. Electricity (see p. 262 of this pamphlet).

12. Drugs. Of these, atropine and strychnine, both by needle, are our chief reliance. Both have the value, beside being active respiratory stimulants, of being also vaso-motor tonics.

II.—HEART TROUBLE.

We now come to the study of the cases in which the leading or the sole factor is heart failure; the respiration meanwhile continuing with a fair degree of regularity and effectiveness. Such instances are more often seen in chloroform- than in ether narcosis. Sundry chloroform commissions have agreed in reporting that dogs die, as a rule, by respiratory

failure, under chloroform. But while this is possible also in the case of human beings, surgeons know that, with the latter, more frequently the heart fails first. Therefore, a good anesthetist, though watching the breathing, never removes his finger from the patient's pulse while exhibiting chloroform. With ether the respiration is the chief danger signal much oftener than is the pulse.

1. *Inversion of the Patient.*—This, the plan of Nélaton*, should be regarded as our first choice when the heart is mainly at fault. No one could read without conviction upon this point the graphic account† of a patient upon whom, when threatened with death from chloroform, Nélaton practiced inversion three several times with final success. The first time she remained inanimate during fifteen to twenty minutes, and at length Dr. Sims believed her dead. When the pulse finally began to be noticeable and she was deemed safe, she was changed from the vertical to the horizontal posture. Instantly all signs of life ceased. Again was the patient promptly inverted, and after an apparently even more hopeless fight than before, the heart

* The story so current, of Nélaton and the mice, is incorrect. It has the basis of fact, however, that Nélaton, Junior, when a child, having, as he supposed, killed some mice with chloroform, was directed by his famous father to suspend one by the tail; whereupon it recovered. Thus Nélaton applied for his boy's instruction a lesson from his own experience in surgery, It will be seen that this reverses the story as usually told. It is here given upon anthority of the junior Dr. Nélaton, who says that he subsequently tried this experiment upon mice "forty or fifty times or more, and always with the same unvarying result." (Dr. J. Marion Sims, "The Story of My Life," pp. 324 325)

Dr. J. Marion Sims, *ibid*, pp. 321–324.

resumed work. Once more the recumbent posture; again, seemingly, death; again immediate inversion. This third time Sims thought her case to be surely hopeless. But not so! And when the heart-beats were at length felt, no one dared to let her lie down until she was both wide awake and kicking vigorously.

Dr. Sims remarks that recovery after one inversion might not be conclusive proof; but that the three collapses successfully met by three inversions, in this lady's case, were to him utterly convincing as to the extreme value of Nélaton's plan—to whose coolness in this emergency he also pays high compliment.

(It is to be regretted that the lack of knowledge in those early days as to the proper technique of chloroform exhibition, and especially as to the modes of prevention of such peril as that described above, should have indued Sims to throw the weight of his influence in America against this anesthetic).

It would be hard to exaggerate the practical value of this plan, although the accuracy of the physiological explanation usually given by way of accounting for its effectiveness may be questioned. Thus, we commonly read that the inversion causes blood to be poured by gravity from the lowermost parts of the person into the anemic brain, which is thus stimulated to send forth more vigorous nerve power to the failing heart. To the writer it seems plain that this is only in part the true explanation; and that, in fact, it can only apply to such blood as may be found in the neck and upper part of the chest. In only one way can blood from any point between the heart and the feet reach the brain if the patient is inverted, i.e., by being pumped through the heart. Certainly

it can *not* by gravity alone. And since we know that mechanical distention of the chambers of the heart by the circulating fluid is a most important factor in exciting cardiac contraction, the proper explanation is not far to seek.

Probably no other operator has relied more fully upon this one method than has Dr. Chisholm of Baltimore; and yet although his extensive record of operations under chloroform (more than ten thousand without a death) makes his opinion deserving of respect, we think there are few who will, with him, stick to inversion alone, and refuse to use artificial respiration—in order to hasten the exit of the narcotized air—and other valuable aids to resuscitation, in addition to Nélaton's plan. Nélation himself used artificial respiration *plus* inversion.

The writer would here urge the general use of the following method, which has several times been used successfully in his clinic, and in the employment of which his assistants are trained:

BEST METHOD.

Upon the appearance of heart-failure during the anesthesia, the patient is slid down the table until his legs drop beyond its lower end, thus making a right-angle with the thighs. The table is now inverted; it is turned head downward. Consequently the patient is instantly in Nélaton's position, and his arms drop loosely on either side of his head. One assistant, only, is needed to hold the patient in place after this is done by clasping the ankles, the legs giving an abundantly long leverage for the maintenance of the right-angle just mentioned.

Now, the operator, facing his inverted patient, seizes the lower part of the chest with both hands

and compresses and relaxes alternately (method of von Nussbaum); his left thumb is in the intercostal space which seems most nearly over the heart (Kœnig); and the acts of compression aforesaid are very rapidly repeated—as much so as possible (Maas); thereby the more quickly pumping ou, poisoned air and pumping in pure air. In addition, it will be noted that following each such emptying of the lungs by the surgeon, the Nélaton posture (by dragging on the pectoral muscles, through the weight of the arms hanging by the sides of the patient's head) causes a mechanical inspiratory act after Sylvester's principle. So that at one and the same time, by the writer's simple suggestion, we can carry into effect the various treatments recommended by all five surgeons named. This fact need not of course preclude the use of yet additional plans, if thought best, at the hands of assistants.

The method of Hill (abdominal compression, the patient lying horizontally upon the table meanwhile), which forces blood toward the heart, while obviously of some value is certainly less efficient for such purpose than gravity, by Nélaton's position. The same is true of tightly bandaging the lower extremities.

2. *Heat.*—It cannot be questioned that among methods of exciting a narcotized heart to resume work one of the most efficient is heat.* A quart or more of water (normal salt solution preferred) as hot as the hand can bear, poured through a funnel, or by irrigator, into the rectum while the patient is inverted as just advised, is standard treatment; and even better is the use of continuous flow by aid

* The writer places it only second in value to Nélaton's posture, and thinks it should always be used as soon as the patient is inverted.

of Kemp's rectal tube, because thereby the heat of the fluid injected is maintained. (The average capacity of the large gut, colon and rectum together, is from a gallon to nine pints). Of course, if hot coffee is at hand, this or other *non-alcoholic* stimulants may be added to such enema.

The patient's body and limbs should not be left uncovered to be chilled, but should be wrapped in warm blankets. This point is important, and too often neglected.

Moist heat applied over the heart is of much value. The late Dr. Sands, of New York, used it repeatedly to the writer's knowledge, who has seen not only this gentleman but several others of the best known surgeons of New York cause a blister several inches square on the præcordium by application of steaming hot cloths during dangerous anesthesia narcosis. Dr. Charles McBurney said some years ago in a letter to the writer: "When the heart flags seriously in ether and chloroform narcosis I regard very hot applications directly over the heart as of decided value as a means of stimulating that organ to renewed activity. * * * I like the idea of your intravascular hot saline injections very much, and shall use it at the first opportunity."

The latter sentence has reference to a plan devised by the writer, whereby heat may with infinitely more directness and efficiency be brought to bear on the heart. This is *to introduce hot salt water directly into the blood current*, and thereby to stimulate both the heart and the respiratory center in the medulla.*

* The hot enema, as just advised, acts similarly, of course; being in part absorbed from the bowels by the vessels; but in an ugly case more speedy heart stimulation than this is called for additionally.

This is so self-evidently a useful proposition as hardly to need argument in its defence. (See article upon "Anesthesia Narcosis" in Vol. ix, *Wood's Reference Handbook*, in which the writer first suggested it).

If, as is generally admitted, heat aplied over the heart can stimulate that viscus—whether directly, by extension through the chest wall until felt by the apex beat, or reflexly—how much more efficient must be that stimulation when that heat is brought directly into the heart chambers, in the blood! The method has additional value as a heart stimulant by increasing the bulk of circulating fluid, and thus accomplishing in a different way what Nélaton's posture does.

Five points have here to be considered: (*a*) the place of entrance, (*b*) the solution for injection, (*c*) the proper temperature of that solution, (*d*) the proper amount, (*e*) the speed of introduction.

(*a*). In most cases, perhaps, a vein or an artery in the operation-wound will offer almost instant entrance to the canula; if not, it is the work of but a few moments to expose any superficial vein, for instance, the median basilic.

(*b*). The fluid should be the "normal* salt solution," which is six-tenths of a part of common table salt per hundred; roughly, a heaped teaspoonful to

* *Normal* in the sense of corresponding with the proportion of NaCl in the blood; and not with the chemical use of the term *normal*.

Let it not be forgotten that *plain water* (devoid of NaCl) thrown into the blood in any considerable amount is promptly fatal by disintegrating the red discs. The writer has witnessed this result upon the dog; see Infusion, in this volume.

the quart, boiled and filtered. This should be instantly obtainable, being kept at hand for another purpose, during severe operations by most surgeons, namely, to *prevent* shock when this is feared, by using intravenous saline infusion while the patietn is still on the operating table.

(*c*). The proper temperature for the injection fluid is *as hot as the hand can bear* (both for treating narcosis and for prevention of shock); upon which point see the chapters on Infusion and Shock. This will be 120° F.* Of course, the temperature at the heart, when the great bulk of blood has diluted the slowly entering fluid, will be much lower than this. There need be no fear of injuring the blood or other tissue by such heat. Verymany times, (against shock mostly, of course), the writer has now used it, as hot as the hand could tolerate, and never with cause for subsequent regret.

(*d*) and (*e*). The proper average amount to be injected against heart failure from anesthesia in the adult may be set down as at least a half liter, and more, up to two liters, if the gravity of the symptoms does not abate. It must for this indication be started promptly, the patient being in the Nélaton position meanwhile, but we must avoid excessive speed of flow. Take five minutes, at least, for a half liter, and stop as soon as a satisfactory condition of the pulse can be noted.

* This fact has very recently been reverified, eight years later, by Dr. R. C. Kemp, also in the Columbia laboratory, showing that 120°F. best stimulates the heart. Experiments have also been made by Dr. Kemp demonstrating that 120° F. is the maximum temperature the average human hand can toleratee hence when no thermometer is available it serves as a safe guide.

3. *Cold.*—Although not so efficient as heat, the application of a piece of ice over the heart, or slapping the præcordium with a towel wet in ice water, will sometimes reflexly excite more vigorous contractions. It will be useless if the patient is under anesthesia "to the surgical degree," for most of the reflexes are then abolished.

4. *Use of Drugs.*—Our fountain syringe and canula are still in place, the latter tied within a vein. Either mingled with the hot salt water, or preceding it, or following it, we may use properly diluted aqua ammoniæ, a remedy of unquestionable value. The latter, with strychnine and digitalis, comprise all the drugs recommended as of real use in this condition by Dr. H. C. Wood, in his Berlin report in 1890, who, however, did not experiment with strophanthus and many other heart tonics. He says: "From 15 to 25 minims of the aqua ammoniæ fortior, diluted with four times its bulk of water, should be thrown directly into a vein of the arm, and repeated in fifteen minutes if necessary."

The only hypodermatic abscess for which the writer has ever been personally responsible was caused by an injection of aqua ammoniæ, (and not the fortior), in a case of extreme opium narcosis with a failing heart; not injected within a vein, as it should have been, but into the subcutaneous connective tissue of the thigh. A slough more than an inch across resulted. The same drug may be exhibited by inhalation—but, with distinct caution, as it is capable of causing violent local inflammation when used in excess.

Regarding amyl nitrite, recommended by Burrall and others, Wood found it inefficient on dogs. Para-

lyzing, as it does unstriped muscle everywhere, and consequently completely dilating the blood vessels, it must inevitably diminish the resistance caused by vascular tone against which the heart has to work in pumping blood, and hence is an indirect heart stimulant. But if that tone be lost from complete narcosis, then it is plain that in such cases at such time this drug would be almost useless, since its *direct* stimulant effect on the heart is but slight. Now, as Dr. Hare points out, paralyzing and dilating the blood vessels is just how chloroform kills. So that amyl nitrite may be said to do more harm than good after the "surgical degree" has been reached. Perhaps, however, it may be of real value in early chloroform collapse which when occuring in the first minute or so of the anesthesia, is due rather to heart failure alone than to association of this with "bleeding into one's own vessels," which comes later, if at all.

Strychnine has already been discussed. Both as a heart and vascular tonic and as a respiratory stimlant it is of great value.

But for this purpose very full doses are needed; —gr. 1-10 by needle need not be feared in the adult. In extreme cases even gr. 1-5 has caused no harm.

Oxygen is also of the greatest value; it helps both heart and respiration.

Regarding digitalis, the testimony is equally strong so far as the heart and vessels are concerned. The writer carries regularly to his operations a solution of strychnine sulphate in equal parts of the tinctures of digitalis and strophantus, and has repeatedly used this combination by hypodermatic needle with benefit.

Strophantus alone he has not employed. However,

since it is more rapid in action than is digitalis, and stimulates the heart vigorously and very much like digitalis, it would seem obviously indicated.

5. *Electricity* in the treatment of anesthesia narcosis is mentioned rather with disapproval by most recent writers. Although the poles are applied to neck and epigastrium, to stimulate respiration by assisting the phrenics, the current would seem as likely to stlmulate the pneumogastrics and thus help to stop the heart. The writer has not personally been convinced that it does any good in these cases.

Two remaining devices the writer has never seen used, but cannot doubt but that they may be of value in absolutely desperate cases. This has been repeatedly demonstrated on the lower animals. They are:

6. Mechanical stimulation of the heart by a long, slender needle passed through the anterior chest-wall (D. W. Buxton).*

7. The other, introduction of a finger through a cut in the præcordium, thus permitting intermittent pressure on the heart through its uncut pericardium; to be repeated some twenty times, at the rate of 70 or 80 times per minute. It is not necessary to empty the heart thereby; a slight pressure will drive on some blood (G. Rowell)†.

In conclusion, it is perhaps needless to say that surgeons employ not one alone but as many as are deemed wise at once from this list of weapons against an enemy that comes unexpectedly and kills quickly if at all. The writer has endeavored to indicate which methods among all of these are most to be relied upon, so far as his personal experiences enables him to judge.

* Anesthetics, 2d edition, 1892, p. 122.

† *Brit. Med. Jour.*, Oct. 29, 1892.

CARBONATED BATHS.

CHAPTER XIII.

CARBONATED BATHS (NAUHEIM).

Though not, strictly speaking, within the domain of this manual, we are induced to devote a chapter to the subject of "Carbonated Baths"—practically the Nauheim treatment at home—that is, in so far as it is capable of imitation. We venture to make this digression, since we believe them of great value, under many conditions in addition to those for which they are employed at Nauheim itself. They are, of course, necessarily modified to suit the special case. From the experience of others, as well as from our own, we believe that they embrace a wider field in their therapeutical application than has been attributed to them. Thus they are useful to reduce temperature, as in typhoid fever, and can be applied even to the domain of surgery.

It is now rendered possible to secure the baths at home, under the direction of the family physician. In certain cases a trip to Nauheim may be preferable, but for the majority this is impossible. We should not, therefore, neglect home treatment by this method, when much benefit can be derived thereby. It is useful in many acute conditions such as would be encountered by the general practitioner. For a more intelligent understanding of the subject we insert an abstract of an article entitled "Baths

of Nauheim and their Therapeutic Applications," by Dr. W. C. Rives. It appeared in the *New York Medical Journal*, April, 11, 1896:

"The baths of Nauheim are three-quarters of an hour distant by rail from Frankfort, on the line from that city to Cassel and Hanover, and within easy driving distance of the well known and more fashionable health resort of Homburg.

"The springs come from a great depth (523 and 590 feet). The two now in use—No. 7, Grosser Sprudel, and No. 12, the Friedrich Wilhelm's Quelle (the figures being used to designate the number of the boring)—spout forth as white foaming liquids, only 32 feet apart, high above the surface of the ground, and are connected with five bath-houses, four in the immediate neighborhood and a fifth (bath-house No. 4) which provides only simple saline baths from spring No. 7 outside the park at a little distance from the others.

"Bath house No. 5, opened in 1892, is much superior to the rest, and is a handsome building completely furnished with every requisite. At the present time there are in the whole establishment at Nauheim 196 bathrooms with 204 tubs. The tubs are of wood, painted, and of large size, so that when a tub is filled the body of the bather is entirely immersed up to the neck.

"Drinking the waters plays but a secondary part, but their internal use is of some value in gouty conditions and disorders of the liver, the Kurbrunnen diluted being said to resemble the Ragoczy spring of Kissingen, and the Karlsbrunnen, the Elizabeth Brunnen of Homburg. The Schwalheim spring, two miles distant, yields a ferruginous water containing carbonic acid.

"The first bath house at Nauheim was opened in 1835, and the baths have been used many years with advantage in gout, rheumatism, rickets, and so-called scrofulous diseases, and have acquired a well merited repute in the treatment of locomotor ataxia and other diseases of the spinal cord. Dr. F. W. Beneke, professor of general pathology and pathological anatomy at Marburg, was the first to show not only that patients with heart disease, more especially those recovering from acute rheumatism, can bear balneological treatment, but that they are actually benefitted by such a course. Beneke, who was physician to the Nauheim baths from 1857 to 1866, wrote several articles upon the effects he had observed there, the earliest appeared in 1859.

"In 1880, Dr. August Schott, who had been making independent studies since 1871, published a paper by far the most important and exhaustive of any that had yet appeared.

"The effect of the Nauheim baths is to regulate the action and strengthen and improve the nutrition of the diseased heart, whether its inability to properly perform its functions depends upon valvular lesions and their consequences or upon malnutrition or disease of the cardiac muscular substance. These results are chiefly due to the chloride of sodium and the more irritating chloride of calcium, the former of which constitutes about four-fifths of the solid constituents, and to the free carbonic acid, which they are said to contain in larger amount than almost any other baths in Germany. They contain, moreover, a considerable percentage of iron, to which may also be attributed a tonic influence. The most powerful though more temporary stimulation, as proved experimentally, is caused by the carbonic

acid. By means of the action of these saline and gaseous contents of the bath upon the terminal branches of the sensory nerves of the skin an impression is made upon the cardiac and vaso-motor centers, by which the heart is reflexly stimulated to more powerful and vigorons contraction and the arteries are more completely filled, and at the same time the cutaneous vesscls dilate, peripheral resistance is lessened, and the whole circulation is rendered freer and more active, while metabolism is promoted and a marked influence exerted upon the trophic centers, as must be inferred from the striking evidences of improvement in the bodily nutrition in general, and in that of the heart in particular, and the persistence and even increase of the good effects long after the patient has completed the course.

"The immediate objective results of the baths are as follows: Examination of the pulse, confirmed by sphygmographic tracings and the sphygmomanometer, shows it to be made slower, stronger, and of increased volume, the cardiac sounds become more distinct, and in cases of dilatation an unmistabable contraction of the heart, demonstrable by percussion and by the change in position of the apex beat, is observed. This contraction is most noticeable in the transverse diameter of the heart, and takes place to little or no extent when the enlargement is solely compensatory, as in many cases of organic mitral and aortic regurgitation. Dr. Bezly Thorne, however, affirms that there is a diminution in the area of cardiac dullness, as measured in the oblique transverse diameter, of a third to about half an inch even in the healthy heart. The respiration becomes easy, and is slower and deeper, and there is usually increased action of the kidneys. Subjectively, a sense

of weight and oppression on the chest, greater than in the ordinary bath, is at first experienced, which quickly passes off; the skin soon becomes warm, and tingling accompanied with redness is felt in its more sensitive parts. Afterward, the patient feels invigorated, and is generally conscious of a sense of drowsiness.

"In administering the Nauheim baths to patients with heart disease, several varieties are employed, for when the effect of one kind of bath becomes less and less marked, owing to the nervous system gradually becoming habituated, a fresh stimulus is imparted by changing to a stronger bath, and thus a longer course can be taken than would otherwise be advantageous. The method employed by Dr. Theodor Schott, which is in the main practised by the other Nauheim physicians, is the following: "The first bath ordered (*thermal Soolbad*) is supplied by the water taken from the receiving basins, from which by exposure to the air a large portion of the carbonic acid has escaped, and a considerable proportion of iron and salts had been precipitated, so that it is of a muddy color and contains few or no bubbles of gas. No. 7 is the spring usually first employed, as it contains the smaller proportion of salts, 2.18 per cent. of chloride of sodium and 0.17 of chloride of calcium. Dr. Schott recommends for some cases, at the beginning of treatment, baths containing only 1 per cent. of chloride of sodium and 0.1 per cent. of chloride of calcium. The natural temperature is 88.8° F., but at first is raised to one varying 92° to 95° F. Temperatures above that of No. 12 spring, 95.5° F., are not suitable for heart patients. The duration of the bath, at first six to eight minutes at a time, while at intervals the tem-

perature is lowered about one degree (half a degree centigrade).

"At first every second or third day, afterward every fourth or fifth, the bath is omitted. The percentage of salts is now gradually increased, which may be done at first by mixing the waters of No. 7 and 12, but is usually accomplished by adding one litre of Manheim's *Mutterlauge* (mother-lye)—the uncrystallizable liquid left behind in the manufacture of salt—which is subsequently increased to two and three liters, or occasionally even more. The main ingredient of this is chloride of calcium, which may be raised eventually in the bath to the amount of 0.5 per cent. When the proportion of salts is thus rendered sufficiently large, the temperature by this time having been lowered several degrees, and the duration extended to not more than twenty minutes, the patient is ready to continue treatment by a course of Sprudel baths from either No. 7 or No. 12, the former containing the greater amount of carbonic acid, the latter of salts. These differ from the others in being supplied with water directly from the springs, before it has undergone the action of the air, so that it appears of crystal color and filled with sparkling bubbles of carbonic acid, which it retains in undiminished quantity. They are likewise at first taken warm, usually at their natural temperatures, and for a short time—about eight minutes—and as they are continued the temperature is lowered in the same cautious way and the duration similarly prolonged. The saline contents may also be increased by successive additions of *Mutterlauge*. In consequence of the powerful excitation of the cutaneous circulation by the carbonic acid which creates an agreeable feeling of warmth, the temperature can

be owered to a degree which could not be otherwise tolerated, but is seldom if ever reduced below 80°F. The final, most powerful form of stimulation is the Sprudelstrombad, in which the supply and overflow pipes of the bath tub are left open, so that in addition to the fresh supplies of carbonic acid, the shock of the running water against the body is experienced. These are not given to many patients in their first season at Nauheim. During the entire period of the administration of the baths their effect is watched with the utmost care, and the character of the respiration, condition of the pulse, and sounds of the heart carefully noted; if, after a half a minute in the bath and the maintenance of a perfectly quiet attitude, a decided sense of cold persists or afterward recurs, the temperature is too low or the bath is in other respects unsuitable. In fact, if improperly administered, especially if too cold or of too long duration, the baths may not only produce no good effect, but may prove positively injurious and even dangerous to the patient by increasing instead of diminishing any existing dilatation, and if the Nauheim treatment ever becomes too popularized, and is conducted by incompetent persons, there is much reason to fear disastrous results.

"After each bath, the patient having been well rubbed, is usually directed to lie down for about an hour. The food and mode of life are regulated in accordance with the usual requirements for heart patients and the physician's orders. No cardiac tonics are ordinarily given, except in extreme cases at the beginning of the course. An ordinary course of baths at Nauheim is estimated at about twenty-one or twenty-five, extending over a period of four or five weeks. This period is sometimes mnch

lengthened, and not infrequently two courses, separated by a considerable interval, are taken in one summer. After the completion of the course, the patient is recommended before returning to the cares of ordinary life to take an 'after-cure' by a sojourn of a few weeks at some quiet, healthful resort possessing a moderately stimulating climate, such as places in the Black Forest, the mountains of North Germany, or localities in Switzerland not exceeding three thousand feet in altitude. The beneficial results of the action of the baths are further greatly increased by means of a series of gymnastic exercises, capable also, when used alone, of powerfully affecting the heart and circulation—the so called resisted movements—the *Widerstandsgymnastik* of P. H. Ling. To quote :

"These exercises are intended to bring into action successively most of the voluntary muscles, and consist of alternate movements of flexion an extension, abduction, adduction, and rotation of the limbs and trunk, such as we are familiar with in ordinary calisthenic exercises or home gymnastics. Against these motions a resistence, graduated in each case to the capacities of the patient, is offered by the physician or a trained attendant. By the interposition of this resistance, the muscular contractions are made more complete and energetic, as well as of sufficient slowness and regularity, which last is a matter of prime importance.

"The resistance is always made by the attendant with the palm of the hand in the direction exactly opposite to that of the movement, and in applying it to the wrist and the ankle, these parts are placed in the fork formed by separating the thumb and fin-

gers; but a limb is never actually grasped, lest support, rather than resistance, should be made.

"The degree of force employed should be as much as the patient can overcome without the slightest discomfort, and should be so uniformly applied as to enable him to perform the movements slowly, evenly, and without jerks. He must be able to breathe quietly, and the mouth and alæ nasi must be watched carefully, so that at the slightest indication of loss of breath a pause may be made. Some of the movements may be omited, according to circumstances; the most trying to the patient are the elevation of the arms above the head and the trunk exercises. The limbs are not allowed by the attendant to fall suddenly after the completion of a movement, and a considerable interval of time is always allowed between each one, and is prolonged if the patient seems at all fatigued. The clothing should, of course, be perfectly loose and easy. The exercises are usually given for about half an hour, the series being gone over twice in that time, but they are often employed for shorter or longer periods.

"Dr. Schott has also devised a scheme by which the services of the attendant may be dispensed with.

"In carrying out these self-resisted exercises (*Selbsthemmungsgymnastik*), as they are called, the patient endeavors, as it were, to resist his own movements by partially contracting at the same time the antagonistic muscles. This demands some intelligence on his part, and it would be often unsafe to allow its employment.

"The action of these exercises is to produce an effect similar in many respects to that caused by the

baths; the cold extremities become warm, the sense of oppression in the chest is relieved, and the breathing deepened. The pulse usually becomes fuller, stronger and slower, and an immediate diminution in the area of dulness in the dilated heart, not due to increased overlapping by the lung, with a simultaneous lessening of the dimensions of the passively congested liver, have been frequently demonstrated.

"Other forms of exercise known to benefit a weakened heart, such as the method of Oertel, the so-called *Terrain-kur*, and the movements by the aid of the Zander machines, which are especially advocated by Dr. Groedel, are employed at Nauheim, where a well equipped Zander Institute has been in operation for the last three seasons. The *Terrain-kur*, however, is too severe a method for many patients who are yet able to undergo with profit the slow, easy, and systematic motions of the resisted exercises, although it may be used wiih advantage when the heart has gained sufficient power. By the Zander machines the force can be adjusted with the utmost exactness, but cannot be so readily altered, while the attendant, applying manual resistance, can instantly vary the amount of force, according to the changing sensations of the patient and the effects produced.

"The effect of the treatment, then, being to powerfully affect the nutrition and increase the strength of the heart, it may be expected to produce the following results: In fresh endocarditis after rheumatism, the baths promote to a high degree the absorption of the inflammatory products and offer hopeful prospects of a more or less complete cure. In chronic valvular diseases, where there is serious damage to the valve segments, they cannot, ordina-

rily produce the slightest effect upon the injured valve itself, those murmurs which disappear during the course, being due to relaxation of the orifices or want of tone in the papillary muscles.

"Although we cannot expect that seriously injured valves should be restored to their normal condition, failure of compensation resulting therefrom is signally benefited, and it is in those cases especially in which digitalis is not tolerated or which has not proved useful that the results are so astonishing. It is well known that in aortic regurgitrtion digitalis is not always beneficial. Good results are secured at Nauheim, however strange it may at first appear, in lack of compensation both from aortic and from mitral disease, as well as in cases of combined disease of both valves, and in many instances, of patent foramen ovale. The gradual influence exerted upon the nutrition of the heart, without the other accompanying undesirable effects, which are often a cause for the failure of medicinal treatment, offers an immense advantage.

"In weak hearts without serious organic lesion—from anæmia, chlorosis, and convalescence from acute diseases, and in the myocardial affections resulting from influenza, most excellent results are obtained, particularly in young subjects, as well as in cases of heart-strain and dilatation, due to over-exertion. In the chronic sclerotic changes (arterio - sclerosis, chronic myocarditis) of heart and vessels, and in fatty degeneration, with or without dilatation, so frequent in persons of advancing years, of which the ordinary treatment is usually palliative, the benefit to be dederived is naturally more uncertain and generally requires long and persistent treatment. Some of the most remarkable results of the Schott methods,

however, have been attained in apparently otherwise hopeless cases, and even patients suffering from angina pectoris have been practically cured at Nauheim. It is easy to say with Professor Huchard, "*Traité clinique des maladies du cœur et des vaisseaux*," second edition, pp. 420) that these are cases of pseudo-angina, but there is no doubt that cases presenting all the clinical features of true angina pectoris due to organic disease have been relieved at Nauheim. It would, of course, be absurd to state that such irreparable lesions as calcified coronary arteries or advanced fatty degeneration, which are often associated with the disease, could be affected by the Nauheim treatment, and while many cases of angina pectoris are hopeless under any circumstances, yet the effect of the Nauheim baths upon the cardiac nutrition is so remarkable, that where the lesions are not too far advanced or only commencing, the results of the treatment are eminently gratifying.

"The results in cases of heart disease dependent upon or complicated with disease of the kidney are less encouraging and more variable, but albuminuria due merely to secondary renal congestion may altogether disappear. Cases of functional nervous disturbrnce of the heart are usually, but not always, benefited.

"The contraindications to the Nauheim treatment are advanced arterio-sclerosis and aortic aneurism. Patients with the latter affection have used the baths with some alleviation of symptoms, but on account of the danger of raising the blood pressure these must be employed with the greatest caution. Many very serious cases of heart disease come to Nauheim, and, as is only to be expected, some deaths

occasionally take place during the season; but such is the care taken by the local physicians, who write their orders with exact directions, that fatal accidents directly attributable to the baths are practically unknown. Groedel states that during a practice of many years at Nauheim, he has never had a case of sudden death during the bath, although he has known of two cases of apoplexy which occurred during the exertion of dressing.

"As to the exact length of time required for a a cure, it is, of course, impossible to say; improvement is usually observed after a week or two, and some patients are relieved by a single course, but many others require a much longer period, and there are comparatively few who are ill enough to undertake a long journey to Nauheim in search of relief, for whom it is not advisable that they should return for another or several successive seasons, while in some desperate cases the treatment will necessarily fail.

The question of Carbonic Acid Baths is of such interest that we insert, through the courtesy of Professor Peabody, Physician to the New York and Roosevelt Hospitals, a paper treating of his own observations at Nauheim. The original article appeared in the New York *Medical Record*, Nov. 19, 1898, and was entitled "Five Weeks' Experience at Bad Nauheim."[1] He speaks as follows:

"It has seemed to me that Nauheim has suffered in two ways in its literature—at the hands of its advocates, who claim too much for it, and at the hands of its critics, who often, without sufficient investigation, in *a priori* condemnation of it. It was in order

[1] Read at the meeting of the Practitioners' Society, October 11, 1898.

to ascertain for myself, if possible, what its methods really are that I undertook last spring to spend some weeks in its investigation. Accordingly, I went there in the middle of May, and remained there until after the middle of June.

Professors Heineman and Schott extended to me every facility for my investigations, and were most kind, not only in affording me access to all the many baths and other public places which interested me, but also in placing at my disposal large clinical material, consisting of their private patients. It was a source of much surprise to me to learn how willingly these ladies and gentlemen lent themselves to my uses, when they knew that I was in search of information which they could convey, either by their histories or by allowing physical examination.

The heart cases which seem to be especially benefitted by Nauheim are of several kinds. They include those in which with valvular lesion compensation is slow in being established; those in which compensation, having existed, has failed, with the result of the production of all the symptoms of failure of the muscular power of the heart; those in which, with or without physical signs, angina pectoris has developed as a symptom, again many forms of cardiac neurosis (other than angina) which may be due to such a variety of causes.

Much has been said and written about the immediate effect of the Nauheim treatment upon a dilated heart, much acrimonious discussion is possible as to the accuracy of physical examination in determining slight changes in a heart's size and position. All of this appears to me so unnecessary, that I was somewhat surprised to see that most of the many doctors who go to Nauheim as I did, seem to think it of

chief importance to examine a large number of patients before and after the baths and exercises, in order to see for themselves what changes take place in the heart, if any, as the immediate effect of the therapeutic procedures. These are points of interest without doubt; but it was to others that I chiefly addressed myself. Before leaving this part of the subject, I may say that I am convinced myself that the apex beat does change in position after the baths and exercises, and that the pulse often becomes slower, fuller, softer and more regular in patients in whom deviation from the normal existed in these respects.

I am permitted by Professor Schott to refer to photographic work of his with the x-rays, which he intended to publish this fall as being convincing ocular demonstration of changes in size and shape and position of dilated hearts, as an immediate effect of baths and of exercises. Professor Heineman, too, has accumulated much material of this kind which shows the same thing and he, too, was most helpful to me in assisting me to look up this part of the subject, as he was in regard to every detail of Nauheim life, therapeutic and otherwise.

This change in size, when it is observable, seems to be chiefly a reduction in size of dilated right heart chambers. I am not inclined to insist upon this as peculiar to Nauheim methods, or as necessarily characteristic of them, or even as of much importance.

Careful observations, according to Sansom, have shown that the bulk of the heart may greatly change under varying conditions within very short periods of time. Broadbent admits a diminution of the volume of the heart under the influence of these

baths and exercises, but adds that such changes in size of the heart are common under other methods of treatment and from various causes.

As I have said, other matters were to me of greater interest than these; to me it is of small moment what may take place in the dimensions of a heart temporarily as the immediate effect of a therapeutic procedure, if the patient does not improve as a remote consequence of it all. And, conversely, if the patient does get steadily and permanently better under any therapeutic procedure, it matters but very little what the intermediate, transitional steps in the process of improvement may be. They certainly are not worth quarrelling about.

What interested me more at Nauheim, after a careful study of all the methods of treatment in vogue and a prolonged trial of the effects of these methods upon myself, was to talk with Nauheim patients, chiefly patients from England, and ascertain exactly what their histories had been, how they had suffered and how long, what their ante-Nauheim condition had been, and how they had borne the somewhat fatiguing treatment, and what changes in their symptoms had been obvious to them in what I may call their post-Nauheim condition. I was enabled by the kindness of these gentlemen whom I have named to pursue this as well as other branches of the subject to the fullest possible extent, and I came away quite satisfied that it is quite common for all the classes of heart invalids which I have named to be materially relieved by the treatment applied. Especially was I impressed with cases of angina, and the great and lasting relief that they derive there. If these cases were few, one would have to think of the possibility of coincidence as ex-

plaining them; but they are far too numerous to eliminate the relation of cause and effect. It is not claimed that one single course of treatment, extending over five or six weeks, is sufficient to bring a permanent relief of symptoms—although this occasionally happens; but many of these heart invalids, whose symptoms under usual conditions are so difficult to cope with, are enabled to lead active lives of usefulness and happiness by an annual resort to Nauheim for four or five weeks.

This is much. It is certainly more than our usual therapeutic means can accomplish. There must, of course, be a shadow side to the picture—there must, of course, be failures in these grave cases at Nauheim; and it is only fair to say that such an investigation as mine is not likely to disclose them.

Subacute rheumatism is greatly benefitted here, as it is at warm springs in general; and one sees many sufferers from cerebral and spinal paralyses, as to whose improvement there seems to be much less available evidence than there is in heart cases. Pelvic and abdominal exudations of plastic character, after they are fully organized, seem to yield to the Nauheim methods; but whether there is anything specific in the Nauheim treatment of these maladies, whether they would not be as well influenced by warm baths and massage elsewhere, may perhaps be open to question.

So many descriptions of Nauheim routine have been published that I have concluded not to ask you to listen to my account of it. I shall merely summarize it by saying that the treatment is in part dietetic; that the physical part of it consists

chiefly of massage, baths in the local water, as well as in this water from which the natural carbonic acid has been allowed to escape, very gentle exercises against resistance which is applied by a trained attendant, together with a period of rest ot at least one hour's duration after each bath and each exercise. One is allowed to walk and drive, but not to incur fatigue or excitement, and is urged to live well, but not to eat heartily at any one meal. Coffee is replaced by tea, strong alcoholics are forbidden, and tobacco is kept within narrow limits.

As to exact details of treatment, there seems to be no consensus of opinion among the Nauheim physicians. One will order more frequent baths than another, or baths of longer duration. All agree that one must not bathe every day, but whether the days of rest shall be one, two, or three a week, seems to be a matter of individual preference among the local doctors. Thus, the duration of baths varies from four to fifteen minutes, according to different advisers. Much the same discrepancy exists as to duration of exercises.

It would seem to be possible to apply this treatment anywhere to a very satisfactory extent. Heineman, who has tried it, thinks that fully seventy per cent. of the benefit may be thus imparted away from Nauheim by careful attention to details. The salts of the Nauheim waters, obtained by evaporation, can be imported in bulk and dissolved in ordinary water in proper proportion to imitate the natural water, and carbonic acid can be dissolved previously in the water, under pressure, so that the two varieties of baths upon which dependence is chiefly placed can thus be arti-

ficially prepared. The exercises can, of course, be equally well done anywhere with trained attendants.

The best results are seen among the well to do, who can afford to give themselves up wholly to the treatment during the few weeks of its application, but they must have sufficient intelligence never to overtax their hearts at any time by over exercise or over indulgence in any way.

That Nauheim methods are not to be carelessly applied, and are potent for evil if too persistently used, admits of no doubt. During the treatment one often feels quite prostrasted by it, and the method in general, as well as the duration of the individual baths, must be carefully adapted to suit the needs and strength of each patient. Too vigorous a course of treatment, baths too frequently administered or of too long duration, can easily produce quite alarming degrees of prostration, and under circumstances, which occasionally may arise, of weakness induced by other causes—such, for instance, as an attack of diarrhœa or bronchitis—the treatment should be wholly suspended.

Nauheim will not accomplish miracles, but I am convinced that its power in heart cases justifies us in giving it very serious consideration. It is certainly a great deal to be able to relieve distressing and even dangerous symptoms, and to enable people to work who have been lead to believe that their days for usefulness were over, as it is also to enable those who are working with undue fatigue and weariness to accomplish their daily tasks with less effort or even with pleasure.

The reader, we trust, having carefully noted the important facts in these excellent articles, is now

prepared to study the technique of the Artificial Carbonated Bath (Nauheim). We will endeavor to demonstrate the simplest methods of imitation and also will call attention to what we believe are certain new therapeutic applications.

THE ARTIFICIAL CARBONATED BATH.

CHAPTER XIV.

Preparation of the Bath.—Dr. John Broadbent points out that a carbonated bath can be prepared by the use use of sea water, which contains 2.7 per cent. of chloride of sodium and by adding for the production of carbonic acid, similar proportions of commercial muriatic acid and bicarbonate of soda or of chalk; also there has been suggested a mixture of the bicarbonate and bisulphate of sodium.

Dr. Satterthwaite calls attention to the dangers arising from the artificial bath, prepared by combining sea salt, calcium chloride, soda bicarbonate, and muriatic acid. On one occasion chlorine gas was evolved in large quantities and the patient was nearly suffocated and the nurse seriously prostrated with bronchitis and laryngitis (John Hopkins Bulletin, October, 1897). The druggist, in this instance, appears to have used the commercial chloride of lime (the hypochlorite of calcium), generally known as bleaching powder, instead of the pharmaceutical chloride of calcium.

Dr. Abraham Mayer's formula: Sodium chloride (sea salt), 30 lbs.; potassium chloride, 10 ozs.; magnesium chloride, 8 ozs. These ingredients are thoroughly mixed and kept in a moisture-proof tin box until required for use. It is advisable to begin

with a weak saline solution, 3 pounds of the above mixture in 30 gallons of water, and increase gradually until 5 pounds of the mixture in the same quantity of water is used. The latter strength closely resembles the Nauheim Spring No. 7, called the Grosser Sprudel, the strongest of the waters there.

Artificial sea water can be prepared moreover, by employing sea salt (such as Powles) or Mediterranean, or even common kitchen salt. Genesee Bath Salt is excellent.

Others prepare a salt bath by a specially devised apparatus. The carbonic acid gas flows from a cylinder into the bath. This process has the disadvantage of being both expensive and cumbersome. Unless a suitable mixing apparatus be employed there might be danger from the gas.

There are several proprietary bath salts, and of these we believe the best, most convenient in form and possessing the merit of cheapness, is that prepared by the Triton Company. They can be secured at their agency, 40 Hudson street, New York City, and at most drug stores. The materials for each bath are contained in a small box and consist of eight large cakes and a package of bicarbonate of soda. These are placed in the salt bath in a manner soon to be described.*

The effect of the thermál Soólbad, which contains precipitated iron and in which there is but little carbonic acid, may be imitated by allowing all the cakes to dissolve before the patient enters the bath.

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* The cakes contain acid sulphate (bisulphate of soda) and also some of the iron salts.

The imported Nauheim concentrated salts (Mütterlange) can also be secured. They contain about 75 per cent. chloride of calcium.

Even the Sprüdel Strombad, the bath of continually flowing carbonic water, the supply and overflow being left open, can be imitated with a little ingenuity. Thus, a mixing-box can be prepared in which the powder, cakes, etc., are placed, and the carbonic water conducted from this by a pipe into the bottom of the tub. The tub can be furnished with a false bottom (perforated), and beneath this fresh powder and cakes can be placed. The overflow conducts off the water, and fresh carbonated water at a definite temperature flows in continuously from the mixing box.

Bath Tub.—A word first as regards the bath tub; a cheap wooden tub is the best to employ, since the chemical reaction of the salts is apt to damage a porcelain tub. In the event of employing the latter to prevent any injury by contact with acid cakes, there are four methods of procedure: 1st. Allow each cake to rest on the lead foil provided in the boxes. 2d. Use three or four ordinary saucers and place the cakes on them. 3d. Use a piece of rubber sheeting, sufficient to cover the bottom of the bath and put the cakes on the sheeting. 4th. Secure a large rubber sheet, fit it to the tub and cut a hole corresponding in size to the outflow hole in the bottom of the tub. The aperture can be button-holed, and through this the cork inserted.

If there is a patent outflow, cut a hole in a small piece of thin sheet-lead and lay it over the opening, or small weights placed about the margins of the rubber sheet and these may be button-holed. Blocks of wood or weights are attached by twine to the edges of the sheet to keep it in position.

The Preparation of the Bath.—The bath should be

of sufficient volume, to immerse the chest and body completely, in the average tub the knees generally protrude. About 40–50 gallons is the average of a bath. *First:*—Dissolve sodium chloride in the bath, about 5 pounds in the first bath, or Powles Sea Salt, or common kitchen salt, Mediterranean Sea Salt, or Genesee Bath Salt.

Second.—Dissolve the bicarbonate of soda that is contained in the paper package.

Third.—Place the cakes on the tin-foil and then on the rubber sheeting, so that they are on each side of the patient and at the shoulders, back, hips and knees.

The effervescence is generally well under way in about three minutes, and this should occur before the patient enters the bath.

The rapidity of the generation of the carbonic is hastened, if an additional ½ pound of soda bicarbonate is placed in the bath after the patient enters it.

Stirring the bottom of the bath by the attendant also has this effect.

Breaking the tablets into small pieces and distributing the fragments increases the elimination of the gas.

The following precautions should be observed :

(*a*) Wet the temples, nape of neck and a small area on the top of the head. This, from experience, we find prevents the full and congested feeling in the head.

(*b*) The sense of oppression in the chest has been frequently observed when the patient first assumes the recumbent posture. This may cause alarm. We recommend just before the bath the administration of fifteen minims to half a drachm of Spts. Ammonia

Aromatic in a little water or a little whiskey and water.

(*c*) We consider it advisable that the physician should be present at the first bath to reassure the patient and also to observe the effect produced. Exposure is prevented by covering with a sheet.

Pulse, respiration and temperature should be taken before the bath; also note the pulse and respiration during the bath, and the effects produced on the patient, and subsequently the pulse and respiration and temperature after removal from the tub.

Variations of a slight degree in the temperature, or length of the bath often affect the patient markedly.

Hour for the Bath :

Preferably during the day, as the subsequent stimulating effect causes wakefulness in many. Some, however, sleep well if given it at night.

We believe it should not be nearer than 1½ hours to a meal. Absolute rest for an hour should follow the bath.

The resisted movements are employed in cardiac cases and at times in circulatory disturbances, neurasthenia, in anemia, palpitation, etc. The patient should be rubbed off quickly by the attendant, and after resting for an hour, resisted movements, when indicated, should be employed. In other cases massage. We give the following abstract, descriptive of the resisted movements.

We quote the following description from Dr. Camac :

THE EXERCISES.

"The exercises are called by Dr. Schott 'Widerstandgymnastik," or resistance gymnastics, and

consist in slow movements executed by the patient and resisted by the physician or operator. A short interval is allowed after each movement, during which the patient sits down. The exertion employed must be very small, and should cause no increase in respiratory movements, flushing or pallor. The patient should be loosely and lightly clothed, and instructed to breathe quietly. The resistance made should be of such a kind that the patient may always feel himself easily the master. The operator must not grasp or in any way constrict the limb, but should oppose by the hand held flatly. The movements are nineteen in number:

Arm. (1) Arms extended in front of body on a level with shoulder, hands meeting; arms carried out until in line, and brought back to original position. (2) Arms hanging at sides, palms forwards; arms flexed at elbow until tips of fingers touch shoulder, back to original position; *one arm only moved at a time.* (3) Arms down, palms forward, arms carried outwards and upwards until thumbs meet over head; back to original position; one arm only moved at a time. *Not always advisable.* (4) Hands in front of abdomen, fingers flexed so that the second phalanges touch those of opposite hand; arms raised until hands rest on top of head; back to original position. (5) Arms down, palms against thighs, arms raised in parallel planes as high as possible; back to original position.

Trunk. (6) Trunk flexed on hips; return to original position. *Rest with both hands.* (7) Trunk rotated to left, to right; return to original position. *Rest with both hands.* (8) Trunk flexed laterally. *Rest with both hands.* (9) As No. 1, but fists

clenched. *Rest with both hands.* (10) As No. 2, but fists clenched. *Rest with both hands.*

Large Arm Movements. (11) Arms down, palms against thighs, *each in turn* raised forwards and upwards until arm is alongside of ear, then turned outward, and arm descends backwards. *Not always safe.* (12) Arms down, palms to thighs, *both together* moved backwards in parallel planes as far as possible without bending the trunk forwards. *Not always safe.*

Legs. (13) Thighs in turn flexed on trunk, opposite hand resting on chair. (14) Lower extremities in turn extended fully, and bent on trunk forwards and backwards to extreme limits of movement, opposite hand resting on chair. (15) Legs in turn flexed on thigh, both hands on chair. (16) Feet together, lower extremities in turn abducted as far as possible and brought back to original position, opposite hand on chair.

Hands and Feet. (17) The arms, extended horizontally outwards, are rotated from the shoulder-joint to the extreme limits forwards and backwards. (18) The hands in turn are extended and flexed on the forearm to extreme limits, and brought back in line with arm. *Resist with both hands.* (19) The feet in turn are flexed and extended to extreme limits, and then brought back to their natural position. *Resist with both hands.*

We have arranged these in 5 groups, as in this way they may be more readily committed to memory."

RULES FOR OPERATORS.

"1. Each movement to be performed slowly and evenly at a uniform rate.

2. No movement to be repeated twice in succession in the same limb or group of muscles.

3. Each single or combined movement to be followed by intervals of rest. Count five.

4. Patient's breathing should not be accelerated.

I. *Avoid.*
1. Dilatation of the alæ nasi (dilating of nostrils)*.
2. Drawing of corners of the mouth.
3. Duskiness and pallor of cheeks and lips.
4. Yawning.
5. Sweating.
6. Palpitation.

If any of the above, make a complete interval, or if excessive, stop the exercises for the day.

5. Direct patient to breathe regularly. If he holds his breadth, make him count in a whisper.

6. Do not constrict the part which is being moved."

INDICATIONS FOR THE CARBONATED BATHS.

First. The Reduction of Temperature.—A valuable result that we can secure from the carbonated baths is the reduction of temperature in fever; associated with this is the elimination of the toxin of the disease through the diuretic action on the kidneys, together with the stimulating effect on the circulation. In other words the action of the carbonated bath is in these respects similar to the Brand Bath (the cold

* The description of each movement is taken (with a few modifications) from "Chronic Disease of the Heart" by W. Bezley Thorne.

bath with continued friction). Hence, as the first indication for the artificial carbonated bath we place

Typhoid Fever.

In this condition, the action of the carbonic acid gas on the body surface takes the place of the friction bath advocated by Brand.

A temperature of 102° F. or more is an indication for the bath.

The temperature of the bath may be from 85°, 75° F., or even 70° F., and the duration from 5 to 15 minutes. It is better to give the first bath at 85° F. and by degrees reduce.

A little stimulant can be given before the bath.

The reaction after the carbonated bath seems more active even than after the Brand Method, and the temperature keeps down for a longer period thereafter, and hence fewer baths are necessary. Renal secretion also seems more active.

Dr. Wm. H. Thomson, we believe to be the first to employ this method in Typhoid Fever. He made thorough comparative tests of the Carbonated Bath, and Brand Bath at Roosevelt Hospital in the early fall of 1898, on many typhoid and typho-malarial cases. He reported his observations in the *N. Y. Medical News*, Dec. 17, 1898. The same results are also noted in a paper read before the N. Y. Medical Association, November, 1899, entitled "Ten Years Experience with Typhoid Fever at the Roosevelt Hospital."

In using the carbonated baths for this purpose, i is advisable to secure very active generation of the gas, and we should employ the devices suggested previously; also make the salt bath rather strong, at least salt up to 15 lbs. to the bath.

It is valuable for the *reduction of temperature* in other febrile conditions, as in gastro-enteritis in children.

In Cholera.—Substitute lukewarm carbonated baths for the Brand bath.

In Neurasthenia-Anemia with palpitation, cold feet and hands, and in circulatory disturbances, etc., the carbonated bath at a temperature of 98°–90° F. and given to the patient for two days in succession and then omit one day and so on—the course of 24 baths. Some cases do better with the bath every other day and others, once in three days.

A temperature of 95° F. seems to agree best and at this constant degree with no further reduction it does well in many patients.

We have been accustomed in these cases to start the bath at 98° F., and for a duration of only three minutes and to increase it gradually daily—one to two minutes in length—lowering the temperature one degree daily until 95° F. is reached or even 90° F. and kept at this, the maximum length being 8 to 10 minutes.

In Renal Conditions—

(*a*) Hyperacidity
(*b*) Chrystalline Urine.
(*c*) Gravel.
(*d*) Renal Insufficiency.
(*e*) Uræmia, or renal insufficiency progressing in that direction, as with eye disturbances, dizziness, circulatory disturbances, etc.

In cases of *Hyperacidity*, *Chrystalline Urine*, *Gravel*, *Uric Acid Diathesis*, the carbonated bath

acts chiefly through the improvement of the general circulation and skin stimulation, and especially through its marked diuretic action. It aids elimination. The average temperature of 98°—95° is employed.

Renal Insufficiency, or *Renal Insufficiency* with symptoms progressing toward Uræmia and evidences of uræmic poisoning, as with dizziness, ocular disturbances, circulatory disturbances, etc.

Some advocate the carbonated baths as hot as 101°—102° F. and taken for a brief period, 3 to 5 minutes, but as a rule they are depressing at this temperature. Some cases, however, give good results. In general 98°—95° is the average temperature to be employed at 3 to 10 minutes duration.

In Pelvic and Abdominal Exudations.—This method of treatment has been advocated for some time past. We have employed the warm bath 98°—95° F. The good effect is probably due to the marked general circulatory improvement promoting absorption.

In Internal Congestion, as of malarial liver or spleen. At 98°—95° F. the carbonic bath is suggested as of value, duration of the bath three to ten minutes.

To Break a Chill and act as a stimulant, as in Malaria or in other diseases, a short hot carbonated bath, 100°—98° F. for three to five minutes would suggest itself.

In Septic Conditions, with or without renal complications as in Diphtheria, etc., to hasten elimination,

though diuretic action on the kidneys, under certain conditions, the carbonated bath might be of value, as at 100°—98° F. for five to ten minutes.

Surgery.

In Surgery. (*a*) We have thus found the full carbonated bath at 98°—95° F. and taken from five to ten minutes, of considerable value in cases of edema about injured joints. It is of service by improving the general circulation, and by its stimulating action on the capillaries and lymphatics, thus aiding to reduce the swelling. The local stimulation about the injured regions seems quite marked, thus we have seen good results in the case of old knee-joint injury, with chronic synovitis and marked œdema of the periarticular tissues.

(*b*) *In Varicose Veins*, with general sluggishness of the circulation, it has been suggested that the full carbonated bath would be of service by the improvement afforded the general circulation and the stimulation of the capillaries and lymphatics.

In Diseases of the Skin.—The carbonated bath has been suggested by some, as of possible value in those diseases of the skin, with sluggish circulation and thickened areas, where stimulation of the skin and resolution of infiltration may be desirable.

In Sprains, either Acute or Chronic.—The local carbonated bath, as hot as can be borne, for 10 or 15 minutes at a time and repeated several times a day, is of value. The local stimulation is much more active than by other methods, and massage subsequent to the bath, therefore, would be more efficacious. This method we know has been employed with success.

For Heart Disease, Angina, etc., we refer to the class of cases treated at Nauheim.—See page 274.

In Heart Disease, 95° F. is the maximum temperature that should be employed. Schott starts the treatment at 92°—96° F., and at a period of six to eight minutes the first bath, and lowers the temperature gradually 1° F., lengthening the bath every few days, at the same time a minute at a time. A moderate amount of sodium chloride, often 1 per cent., is employed at the start and this is increased as the temperature of the bath is lowered.

In some cases the baths were lowered even to 80° F. and prolonged for 20 minutes. As Professor Peabody demonstrates there is considerable variation in this regard among the different physicians.

Angina is often also benefited.

As far as our own experience with the artificial carbonated baths, we have employed them first at 95° F. for three to five minutes; three to five pounds of salt to the bath and gradually increased the duration by a minute every few days, lowering the temperature 1° F. in the same proportion, 10 to 12 minutes being the final limit as to length. The quantity of salt is increased as the temperature is lowered, up to 15 pounds to the bath. The baths are to be given for two days in succession, and then omitted one day and so on.

Local Carbonated Baths.—As an example, a patient with a rheumatic swelling of one ankle ordinary hot foot baths, hot salt foot baths and hot douching were tried, but with scarcely noticeable results. We gave the swollen ankle a local carbonated bath in an ordinary crockery basin for about 10 minutes, three times a day, increasing the temperature

of the foot bath to as high a degree as he could bear. The relief was immediate and the swelling began to decrease and soon disappeared. One box of the bath salts, divided up was sufficient for five or six of these foot baths. The preparation was the same as the full bath, but required about a handful of salt and only one or two tablets crushed up and a handful of the soda bicarbonate.

Rheumatism.

(*a*) *Acute Rheumatism.*—Hot or warm bath at 100°—98°—92° F. is given at times with good results, for five to ten minutes daily, for several days.

(*b*) *Subacute or Chronic Rheumatism.*—We have observed good results from carbonated baths, at 95° F. and reduced to 90° F., though averaging 92° F., of five to ten minutes duration, baths intermitted as before.

(*c*) *Muscular Rheumatism* is benefited by the same method.

(*d*) *In Rheumatoid-Arthritis*, the carbonated bath would be of service.

In Locomotor Ataxia and similar conditions, often benefit is found from the bath.

Since, in our opinion, every therapeutic agent that is of assistance to the patient, should invariably be employed, we have described the artificial carbonated baths at considerable length, believing that their application in practice should be more widely extended. In the succeeding chapter, we shall discuss certain remedies and demonstrate new instruments. Experiments of interest will also be described.

THERAPEUTIC ADDENDA.

CHAPTER XV.

THERAPEUTIC ADDENDA.

In this chapter we desire to call to the attention of our readers a few formulæ that have proved of service, and to present some useful instruments. We shall also discuss special therapeutic applications of remedies, and in addition, experiments with anesthesia and antistreptococcus serum.

For the purpose of counter-irritation as in sciatica, intercostal neuralgia, etc., we have found the following to be useful:

℞	Oil of mustard	m 10.
	Menthol,	grs. 10.
	Alcohol (95%)	ʒ i.

Shake. Sig. Apply a few drops externally, rubbing in well.

This preparation is volatile and will not blister as some might suppose.

FOR INFECTED WOUNDS, ETC.

Label "campho-carbolic solution."

℞	Acid carbol	ʒ ii.
	(by volume)	
	Camphor pulv.	ʒ ii.
	Alcohol (95%)	ʒ vi.

Mix carbolic and alcohol and then dissolve the camphor.

Sig. External use as an application in infected wounds.

Advantage is taken of the antidotal effects of alcohol to carbolic.

Some years ago camphor and carbolic were combined, but were found irritating.

Camphor is an analgesic.

This preparation is excellent to remove a slough, painting a small amount over the surface. In infected vaccinations, surround the area with boric ointment, to prevent injuring the healthy skin. Moisten the surface with the solution and cover it with thin gauze.* The edges of the rubber tissue can extend beyond the ointment and the dressing can be strapped on with adhesive plaster. Only a few drops of the preparation are used at each dressing and it can be moistened once or twice a day. We have had excellent results in the treatment of chancroids, the rest of the organ being well smeared with ointment. We suggest its employment in applications to the cervix as superior to carbolic aud causing no cicatricial contraction.

CONTRACTILE COLLODION IN LOCAL ANESTHESIA.

We find this of value in operations under local anesthesia, employing it as a restricting band to prevent absorption of the cocaine, completely encircling the site of operation with a wide stripe of the collodion. The use of flexible collodion in erysipelas is well known, and the contractile collodion interferes more markedly with lymphatic absorption It is serviceable where no tourniquet can be applied as on the cheek, abdomen, etc. It causes a slight edema, and by interfering with the lymphatic circulation, and hence lessening the absorption, en-

* Rubber tissue is placed over the gauze. Small perforations should be made in the rubber tissue which covers the gauze.

ables less solution to be employed. The pressure also renders the part somewhat analgesic. The contractile collodion is an excellent substitute for the pressure ring (rubber), which has been employed.

AMYL NITRITE IN CONVULSIONS.

As an antispasmodic, Dr. H. C. Wood reports successful results in combating strychnine convulsions in rabbits, when the nitrite was administered hypodermically. We have employed it in acute uremic convulsions, even in cases where no high tension was noted. We were enabled to secure almost immediate relief from the convulsions and to avoid the use of morphine injection.

OXYGEN IN SEPTIC CONDITIONS, UREMIA, ETC.

There has been considerable discussion among our various authorities concerning the value of oxygen, some believing it to be practically of little value, while others hold the opposing view,

There are certain "empirical results," if we so choose to call them, that oxygen produces.

As to Anesthesia.—If we administer nitrous oxide alone and then stop this anesthetic and allow inhalation of air, recovery from cyanosis is less rapid than if oxygen be administered.

2. In carbon-dioxide poisoning, opium poisoning, etc., the value of oxygen has been demonstrated.

3. In cyanosis, immediate relief has been produced

by oxygen, even when artificial respiration seemed to result in little benefit.

4. In pneumonia, etc., the patient often notes that respiration is easier and pain is lessened.

There will frequently be an improvement in the circulation and respiration after the administration of oxygen.

Many of our most eminent clinicians claim that the only benefit secured from oxygen is temporary, and due to the relief of cyanosis and for such only employ it as in pneumonia.

It would seem that one cause of failure of the remedy is that it is almost always used as a "dernier ressort."

The early employment of oxygen is the only fair test. It would appear that if used at the commencement of pneumonia, or as in broncho-pneumonia (secondary to grippe bronchitis), it presents certain advantages; stimulation of respiration and circulation, and hence improvement in all the secretory functions, should result. If such were the case, absorption of inflammatory products would be aided, as in pneumonia or even in pleurisy with effusion. Possibly some mechanical dilatation of the bronchioles occur, caused by such inhalation, and this aids to prevent the collapse of fresh bronchioles.

In scarlatinal nephritis, the red cells are diminished in quantity, hemoglobin is diminished markedly and there is leucocytosis. Oxygen should be of service and should improve the general functions and aid elimination.

We would advocate the employment of oxygen in sepsis, uremia, and in any toxemic condition to im-

prove the respiration and pulse, and hence the secretory functions, and consequently as an aid to elimination. It would seem as logical as washing the blood.

FIG. LXV.

A Double-Current Irrigator for the Vagina.

NEW VAGINAL IRRIGATOR.

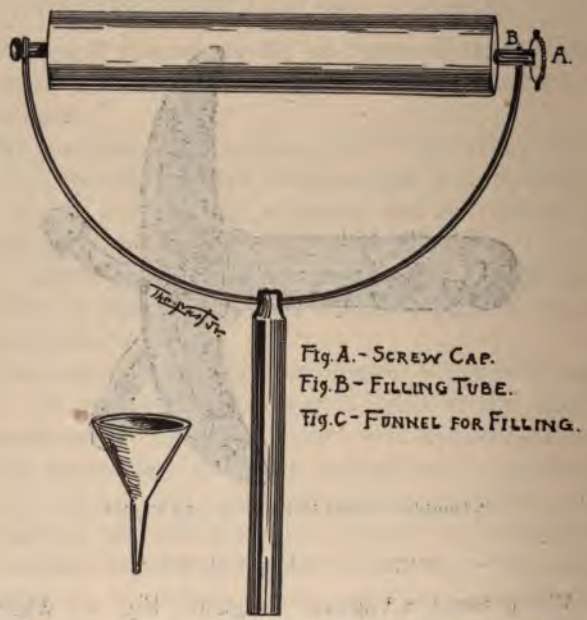
We present a vaginal irrigator, Fig. 65, which it is possible to employ without a bed pan. The central tube and cap with perineal curve, unscrew. The fountain syringe is attached to the central tube with the upward curve and the outflow tube to the tube curving downward. The instrument is made of hard rubber and also of glass, but the latter is not durable. Reported in the N. Y. *Medical Journal*, April 11, 1896.

DOUBLE-CURRENT (CHAMBERLAIN) TUBE.

This instrument is to employ for irrigation as a Chamberlain tube, but on the model of the double

current glass irrigator. Reported in the N. Y. *Medical Record*, Oct. 10, 1896.

FIG. LXVI.



Dr. R. C. Kemp's Metal Roller Water Tank, For the Application of Heat or Cold.

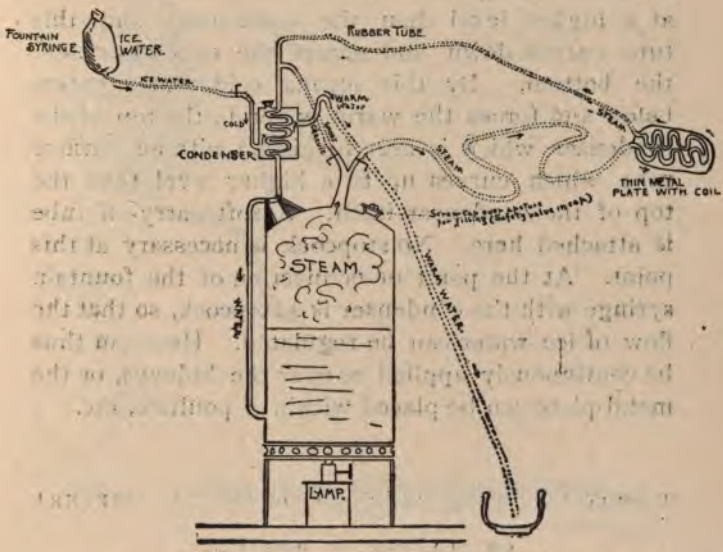
A Metal Roller Water Tank for the Application of Heat or Cold (Counterirritation).

METAL ROLLER WATER TANK.

The illustration (Fig. 66) explains the instrument, a rolling hollow cylinder which is filled with the funnel through axle B. This is closed with cap A. Hot water can be employed, as in sciatica, muscular rheumatism, stiff neck, lumbago, etc. It can be

used to rub in lanolin ointments*. Cold can be used in neuralgia. See *Medical News*, May 12, 1900.

FIG. LXVII.



Continuous Steam Coil for the Application of Heat.—(Kemp.)

CONTINUOUS STEAM COIL.

In Fig. 67 we demonstrate a useful instrument. Steam passes up into a Y, each branch of which is furnished with a stop cock. One branch of this is connected by a soft tube, with a thin metal coil, and the steam from this returns to the condenser and thence to the bottom of the tank, as

* The roller should be lubricated with olive oil, which does not amalgamate with the ointment. It is of value in inunctions for syphilis, etc.

water.* The other branch of the Y is also connected with the condenser. By means of the stopcocks the amount of steam that is to enter the coil is regulated, and no loss of steam can occur. The fountain syringe is connected with a metal tube at a higher level than the condenser, and this tube curves down and enters the condenser near the bottom. By this means cold water enters below and forces the warm water to the top of the condenser, which is here furnished with an outflow tube which curves up to a higher level than the top of the condenser itself. A soft carry-off tube is attached here. No stopcock is necessary at this point. At the point of connection of the fountain syringe with the condenser is a stopcock, so that the flow of ice water can be regulated. Heat can thus be continuously applied as over the kidneys, or the metal plate can be placed within a poultice, etc.

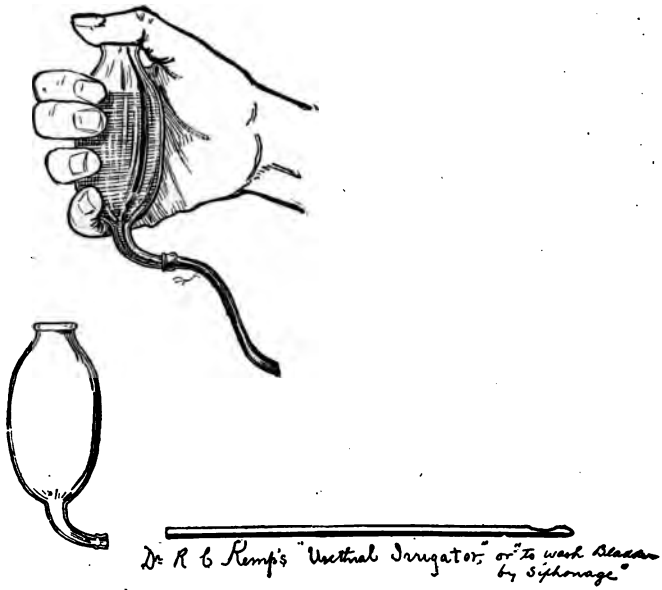
HYDROSTATIC-PRESSURE IRRIGATOR FOR THE URETHRA OR BLADDER BY SIPHONAGE.

Every physician is cognizant of the danger of too forcible injection with the hand syringe, in cases of gonorrhea, and how easily infection is carried thereby into the deep urethra, or even into the bladder. The simple device in Fig. 68 serves to irrigate the organ, by hydrostatic pressure and to minimize this danger. The idea was suggested to us from the Birmingham nasal douche. It consists of a glass bulb of the capacity of two and a half to three

* There is a water guage in the return tube.

ounces. As demonstrated in the illustration, the thumb placed over the opening will check the inflow

FIG. LXVIII.



at once. A catheter is attached to the bulb. It must be of the smallest size, for the pressure will not otherwise be sufficient to force the fluid out around the catheter. A second opening may be cut in the catheter, near the eye, on the opposite side, not to weaken it, and this may be made into a velvet eye by burning the opening over an alcohol flame, and quickly wiping it smooth with the moistened finger. It is even possible to irrigate the bladder with the instrument on the "siphon" principle, though, as a rule, a larger bulb, or one with a larger opening is preferable to secure greater pressure.

FIG. LXIX.

Chambers' Portable Bath Tub.

CHAMBERS PORTABLE BATH TUB.

This bath tub, Fig. 69, is of soft rubber and is readily folded into a package, twelve by eight by four inches, or more longitudinally, eighteen inches long and thirteen inches in circumference. It can be carried in a bag of moderate size and is very light. It can be unrolled beneath the patient like a draw sheet and the corners attached to the

bed posts. An iron brass cot is preferable. There is a grommet at each corner and a cord with self-retaining attachment, one on each side to use if necessary. There is an outflow and an overflow. The conducting pipe from the latter can be turned up over the edge of the tub, so as to fill it to its capacity, if desired. When set up it is six feet long, one and a half feet wide and sixteen inches deep.

To Preserve the Rubber.—Sprinkle over it powdered French chalk or flowers of sulphur.

To Mend a Leak.—Sandpaper the aperture on the inside of the tub. Cut a spherical piece of rubber sheeting. larger than the hole. Sandpaper the surface of this and glue it over the hole (inside) with rubber cement.

This tub would be useful in cases where unsafe or inconvenient to move the patient to the bathroom, as in private practice, or where there are no facilities.

Its application for the Brand Bath, carbonated bath, etc., would be invaluable.

It can be secured at Galpins, 57th street and 6th avenue, and at a reasonable figure.

FIG. LXX.

Instrument to Apply Heat or Cold to the Alveolus.

WATER COIL FOR THE ALVEOLUS.

This instrument (Fig. 70) consists of a thin metal plate, about an inch long and about one half an

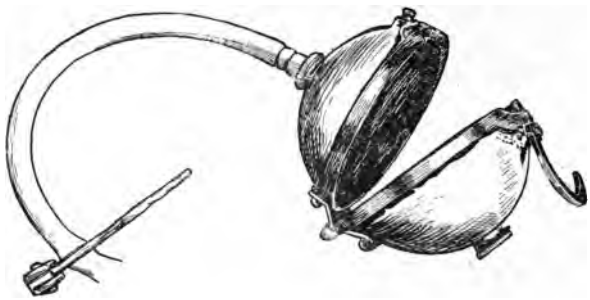
inch vertically, and curved to fit the gum. A thin metal coil is soldered on, as demonstrated. A fountain syringe tube and outflow tube are attached. It is excellent for the application of heat or cold to the inflamed alveolus, ulcerated teeth, etc.

FURTHER EXPERIMENTAL RESEARCHES ON THE EFFECT OF DIFFERENT ANESTHETICS ON THE KIDNEYS.

Merely a brief abstract can be given. The experiments were performed on dogs by Dr. Wm. H. Thomson and myself. Fig. 1 in Chapter II., p. 23 demonstrates our method. A description is given on pages 22-24 of the operation, with the exception that the enclosure of one kidney in the oncometer is not described.

The condition of the circulation of the kidneys can be accurately determined by an instrument first devised by Prof. C. R. Roy, of London and called the kidney oncometer.

FIG. LXXI.



Hoyt's Oncometer.

As shown in the cut (Fig. 71), the oncometer is a small, bivalved, kidney-shaped metal box, hinged at the back, with a clasp in front, while a grooved

notch at the center of the rims of the valves prevents pressure on the vessels and nerves of the pedicle of the kidney, when the organ is enclosed in the oncometer.

Lying loosely upon the inner surface of the valves, but fastened to their rims by detachable metal bands, are two pieces of thin soft rubber, which, when filled, so allow a layer of water to be interposed between them and the metal walls of the box that when the two halves are shut down upon the inclosed kidney it rests upon a perfect water-pad. A short metal tube in the center of the upper valve, to which is attached a piece of soft rubber tubing, allows the water in that lid of the oncometer to rise and fall in the tube, according to the expansion and contraction of the inclosed kidney. This movement in the water column is communicated to a column of air farther on in the tubing, which in turn communicates with the air in a closed drum, or tambour, on the upper surface of whose diaphragm rests the long lever of the registering pen, which thus records the oncometric tracing upon a moving sheet of smoked paper. The use of water as the liquid in the oncometer pad is a great advantage over that of oil employed in Roy's instrument, and this improvement we owe to Mr. J. T. Hoyt, the practical electrician and machinist in charge of the physiological laboratory of the College of Physicians and Surgeons.

A special tambour was also made for us by Mr. Hoyt, which gave us much better tracings of the kidney than the instruments of Hürtle or Marey.

We give oncometric tracings which illustrate the difference between normal and high pressure curves (see Fig. 72). The lower tracing represents the lines made by a normal kidney, while the upper one

shows the marked contrast when the renal vein is tied.

There are certain physiological laws which regulate the functions of the kidneys (see p. 31).

FIG. LXXII.

High Pressure Curve.

Normal Curve.

It can be readily seen that it requires but slight disturbances to unbalance this delicate equilibrium.

Thus, from wetting the feet, or by a sudden exposure to a draught of air, there may result an acute congestion of the kidneys, showing how interference with the maintainance of the proper relations between the renal and general circulation influences the renal secretion itself.

When, therefore, the statement is made that the anesthetic is a rare factor in producing derangements of the kidney functions, or in aggravating those which already exist, it seems at least to run counter to the fact that there is no known anesthetic, administered in any effective quantity, whatever the method of administration, which does not affect the renal circulation.

We should like to call to your attention the following propositions:

First. Any *anesthetic whatsoever*, violating as it must necessarily do those laws of physiology relating to the circulation and secretion of the kidneys, and to which we have already directed your attention, may therefor be a "*factor*, or an *accessory factor*," in causing disturbances of the renal functions. Hence renal complications may follow any anesthetic.

Second. Though renal disturbances may follow any anesthetic, and even cause a fatal issue, yet owing to such factors as the personal equation of the patient himself, the skill of the anesthetist, the nature and quantity of the anesthetic, the length of the operation, etc., there may frequently be no albuminuria or other changes found in the urinary examinations made in our hospitals. Also, slight changes may occur, but they are often evanescent, and by the end of twelve to twenty-four hours all evidences of derangement may have disappeared.

Third. In our physiological experiments, however, we have *invariably* noted a marked difference in the effects produced on the kidneys by the different anesthetics, as is shown by a glance at the original tracings and by drawings taken from instantaneous photographs of them, which we herewith exhibit. These drawings are by Thomas Nast, Jr., from photographs taken by Dr. Cunningham. We tabulate the effects produced as follows:

EFFECTS OF ANESTHETICS.

CAROTID TRACINGS. *Circulatory Effect.*	KIDNEY TRACINGS. *Kidney Effect.*	URINE. *Analysis.*
ETHER.—Fig. 73. Pressure rises. Rises slightly when pushed. Moderate fall when removed.	Evanescent rise. When pushed a marked fall even to base line or below it, and even a total disappearance of the waves. It takes some time for the kidney to recover, even after the anesthetic is removed. Not due to vascular tension, as the same occurs with the mixtures, with a chloroform heart; yet kidney traces are not of chloroform, but of ether. Ether has a specific effect on the kidneys.	Quantity rapidly diminish as the ether is pushed. Finally complete suppression occurs. Albumen appears early and increases to 60 per cent. by volume.
CHLOROFORM.—Fig. 74. Evanescent rise of pressure; then a fall of pressure, becoming more marked as the anesthetic is pushed; pressure rises when removed Type of low tension anesthetic	Follows the carotid tracings absolutely. Become shorter as they approach base line, but never reach this line, nor do they disappear. They remain parallel to the general circulation, and evidently dependant upon it. No specific effect.	Quantity copious, only diminishing as the circulation is depressed. Secretion continues to nearly time of death. Albumen small in amount.
A. C. E. MIXTURE (alcohol, chloroform, ether).—Fig. 75.		
By open method like chloroform.	By open method, like chloroform.	By open method, like chloroform.
By semi-closed or closed method, pronounced chloroform.	By semi-closed or closed method, like ether, but less pronounced (as less ether). Specific effect of ether.	By semi-closed or closed method like ether, but much less pronounced. Albumen moderate.

EFFECTS OF ANESTHETICS.

(*Continued.*)

CAROTID TRACINGS. *Circulatory Effects.*	KIDNEY TRACINGS. *Kidney Effect.*	URINE. *Analysis.*
SCHLEICH'S ANESTHETIC MIXTURE (three strengths: chloroform, ether, benzine—petroleum ether).—Fig. 76. By open method, like chloroform. By semi-closed, or closed method; pronounced choroform.	By open method, like chloroform. By semi-closed or closed method. Ether effects more pronounced than A. C. E.; less than with ether. Specific effect of ether	By open method, like chloroform. By semi-closed or closed method. Ether effects more pronounced than A. C. E., less than with ether.
ANESTHOL (ether, chloroform, ethyl chloride). Dr. Willy Meyer.—Figs. 77 & 78. By open method like chloroform. By semi-closed or closed method. Exaggerated chloroform; worst of all, and especially to be noted we have marked respiratory poisoning, tremors, convulsive movements, twitchings and crying noises. This is due to ethyl chloride, as later demonstrated.	By open method, like chloroform. By semi-closed or closed method. Like ether, possibly traces recover more rapidly, yet we have complete suppression. Specific effect of ether.	By open method, like chloroform. By semi-closed or closed method. Complete suppression from the start, only a little blood and albumen.
NITROUS OXIDE (type of high tension anesthetic).—Fig. 79. Marked rise of pressure On removal pressure falls rapidly to normal. No cardiac depression unless respiration is affected by pushing too deeply.	Effects due to high tension, arterial contraction. Respiratory waves, long, are marked. Kidney waves are short and vertical. If pushed, fall to base line and even disappear. Rapid return to normal if anesthetic removed. No specific effect.	Quantity diminished. Small amount of albumen, which disappears on removal of anesthetic.

FIG. LXXIII.

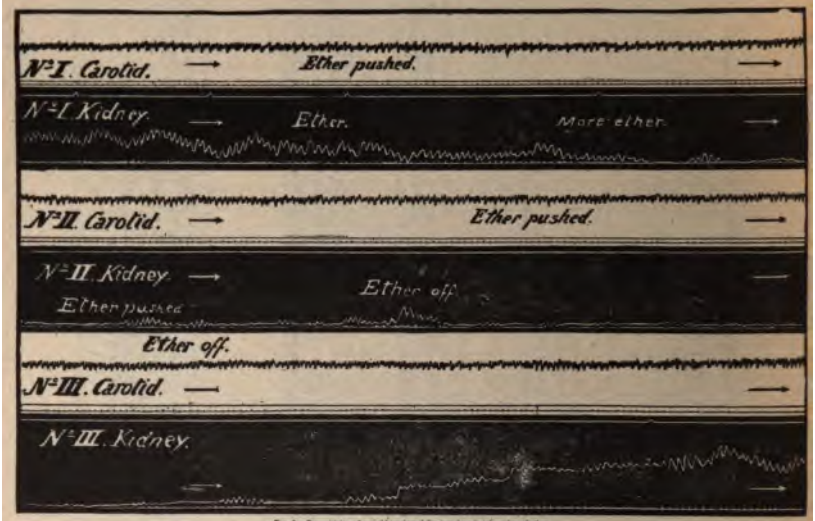
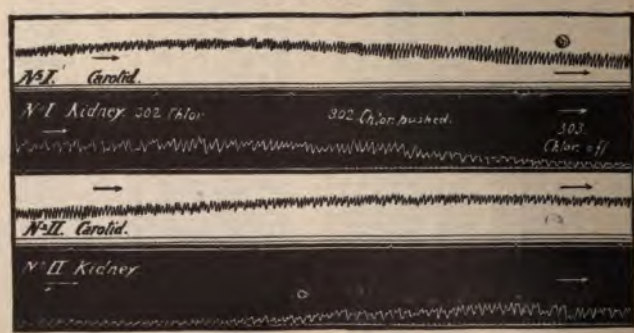


FIG. 5.—Oscometric and carotid tracings following the administration of ether.

Ether.

FIG. LXXIV.

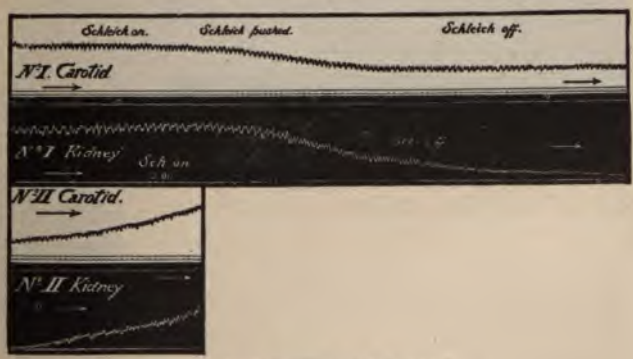


Chloroform.

FIG. LXXV.

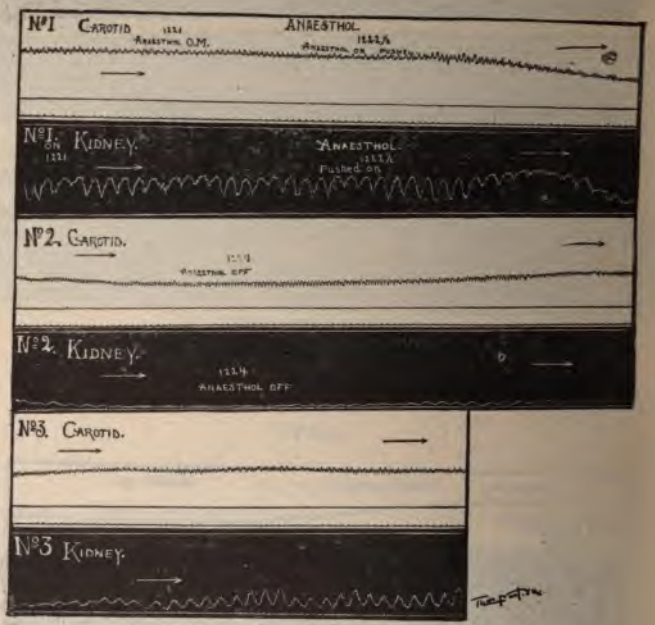
A. C. E. Mixture.

LXXVI



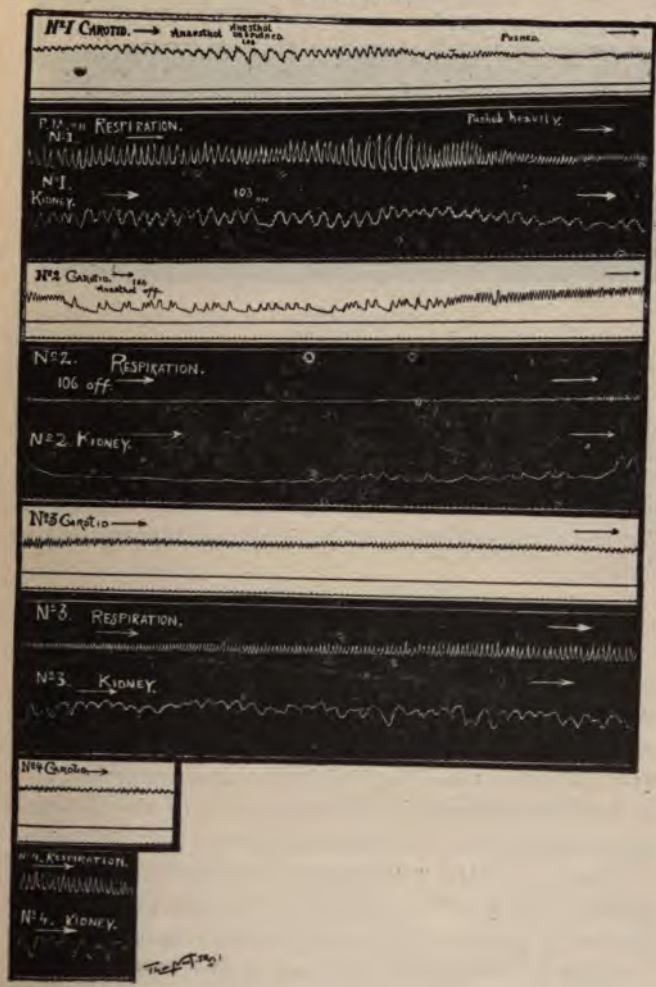
Schleich's Anesthetic Mixture.

LXXVII.



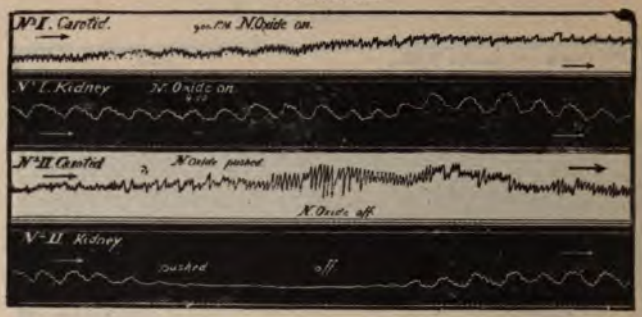
Anæsthol.

FIG. LXXVIII.



Anaesthol.

FIG. LXXIX.



Nitrous Oxide.

That the respiratory poisoning is due to the ethyl chloride was demonstrated as follows: A cat was put under chloroform, ethyl chloride was then substituted when all the symptoms followed of the respiratory poisoning that occurred with anæsthol. We were obliged to resort to artificial respiration in addition.

Ethyl chloride is an anesthetic.

Schleichs Anesthetic.—Dr. S. J. Meltzer experimenting with benzine (petroleum ether) one of the ingredients of Schleichs anesthetic finds that it possesses no anesthetic properties. If it is inhaled alone, with rabbits tetanus and opisthotonus are produced. If it is discontinued at the appearance of the convulsions, a paresis of the extremities results. If ether is given with it, the tetanus movements are suspended, but not the paralytic after effects; the rabbit dies of paralysis of the respiratory muscles.

Schleich finds, however, that quite large subcutaneous injections of benzine can be given with no bad effects. We repeated this and find the same. Schleich concluded benzine was harmless. Meltzer

shows by inhalation it is noxious, and we find the same results in this regard. In other words a respiratory poison by inhalation, but not by injection.

In order to eliminate respiration as a factor we curarized a number of animals. We secured the same results from the anesthetics, but it required a longer period of time. We thereby discovered another interesting fact.

In the mixtures, a great element of danger is that the more volatile ether will act as a vehicle for the chloroform and this is the more serious when the closed methods are employed. Thus, in the curarized animals a considerable period of time elapsed before effects were produced on the carotid or kidney tracings by pure ether or chloroform, but if any of the mixtures were employed, A. C. E., Schleich, or anæsthol, an instantaneous chloroform heart resulted.

This demonstrated that in the mixtures the ether acts as a vehicle for the chloroform.

Mr. J. C. Minor, Jr., demonstrated the same by chemical experiments.

CONCLUSIONS.

Ether is a Cardiac Stimulant.—A specific action on the kidneys and deleterious in this regard.

Effect on kidneys not due to high tension but is specific.

Nitrous Oxide is a Cardiac Stimulant.—No specific action on kidneys ; effect due to high tension.

Best anesthetic, if kidney disease. Safe for long operations if given by an expert and with oxygen. Under such conditions we consider it the safest anesthetic.

Chloroform is a Cardiac Depressent—(vascular dilator)—No specific effect on the kidneys; only secondary to low tension.

In kidney disease is next to nitrous oxide as a safe anesthetic.

Nitrous Oxide and Ether are Cardiac Stimulants.—Anesthetize well with nitrous oxide and then change to ether and employ scientific inhaler, as Clovers or Dawbarns, using minimum quantity of ether. Effect on the kidneys is much less and is the safest method to employ ether.

A. C. E. Mixture, Schleichs Anesthetic Mixtures, Anaesthol.—By the open method the "pretty anesthesias" are secured, *i. e.*, chloroform.

By the semi-closed, or closed methods.

Mixed effects.
1. Chloroform heart, more marked.
2. Ether kidneys.
3. Quantity of various anesthetics cannot be measured.

a, Benzine in Schleich's mixtures, a respiratory poison by inhalation.

b. Ethyl chloride in anæsthol, a respiratory poison by inhalation and evidently damage of marked character to the kidneys results (blood appearing, and albumen and total suppression.)

We find by clinical investigation that

1. *Indican* is produced by ether, or markedly increased if present.
2. Chloroform acts in this regard to a less degree.
3. Nitrous oxide, the least of all.

This is significant, as it corresponds to the results produced in regard to the digestive and renal disturbances.

We believe this was not previously noted.

CLINICALLY.

In 1898 at Roosevelt Hospital, of all the deaths following operation 5.5 per cent. could be traced to ether, as a factor, or accessory factor, due to the effects produced on the kidneys. Many other hospitals gave us a larger percentage. It is interesting to note that for some time past nitrous oxide has

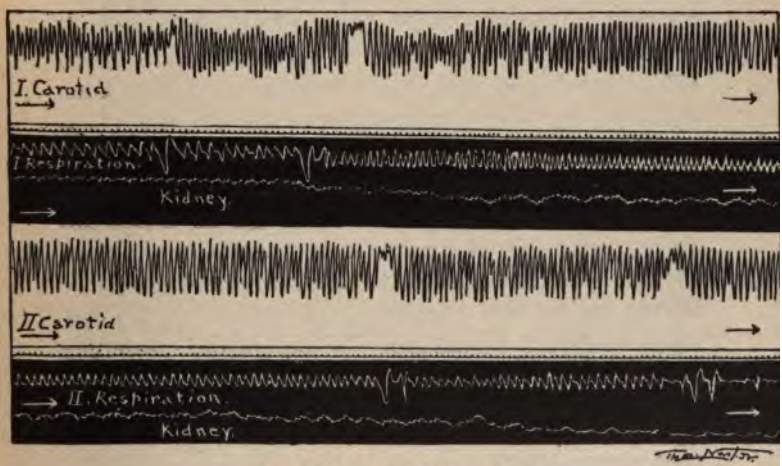
been first administered, followed by ether, and with resulting improvement in the records.

ANTISTREPTOCOCCUS SERUM.

In chapter 2, Experiments, the effect of Antistreptococcus Serum and Normal Serum injections was described; also the action of normal saline solution in relieving the kidney congestion caused by them.

We show in Fig. 80 as a possible matter of interest, tracings following the injection of antistrepto-

FIG. LXXX.



Effect of Antistreptococcus Serum

coccus serum in large doses, and demonstrating the effects produced on the kidneys under such conditions. The original article appears in "The Transactions of the Association of American Physicians," vol. xiii, 1898, p. 402, entitled. "A Case of Infective Endocarditis," etc., by Drs. Wm. H. Thomson and R. C. Kemp.

ADDENDA.

In connection with our manual we note certain omissions which we here insert.

Enema.—In sepsis a high enema of normal saline solution at 110°–120° F., as in shock (see pp. 44–51), a pint to a quart injected and to be retained, may prove to be of value. If a low enema be employed, a lesser quantity should be used (℥ii to Oss). A temperature of 110°–120° F. is some times more efficacious in tympanites, or intestinal colic than solutions of the lower temperature (102°–103° F.), see pp. 43, 44, 52. In infantile convulsions, the enema may be of the same temperature as in the simple enema to secure bowel action, though at times the higher temperature (110°–120° F.) seems more beneficial. The hot enema is also of service in renal or biliary colic. In apoplexy, the enema is also of value to divert blood from the cerebrum. Further indications for the enema, that is to be retained, are the same as under Infusion.

Hypodermoclysis.

Hypodermoclysis is also of value in pneumonia, to serve as a cardiac stimulant and to aid in the elimination of toxins through its diuretic action on the kidkeys. Dr. Tuttle reports to us good results during his service at the Presbyterian Hospital.

Hypodermoclysis in Preparation for Operation, or During Anesthesia; Indications: One frequently sees

patients brought to a hospital suffering from traumatism, such as a compound fracture, or even cases requiring minor amputations, in which there has been some loss of blood, and moderate stimulation may be necessary. We do not mean a condition of true shock, or a border-line case even, when infusion would be indicated. The customary procedures of heat, strychnine, whiskey, and hot rectal enema may have been employed. In such a case we advocate a preliminary saline hypodermoclysis of moderate size (℥vi–viii), to replace the loss of blood and to be given before operation. The somewhat slow absorption under such conditions could not overstimulate the heart and cause increased hemorrhage at operation, an objection that has been made to preliminary infusion in moderate collapse. We believe in just such cases hypodermoclysis to be an ideal method, to be followed on the operating table by a hot saline infusion for the "prevention of shock," as first suggested by Dawbarn. In other words, a hypodermoclysis given as a "preventive" on the same principle, with the "hot saline enema" added, may often render the "preventive infusion" unnecessary. I do not mean to minimize the value of "Dawbarn's method," since I thoroughly advocate it, having frequently seen its good results. I merely follow in his footsteps, believing that more attention should be paid even to slight hemorrhage before operation, and by replacing this loss of blood I aid in eliminating some danger.

In a case in which Renal Trouble is suspected, or is known to exist, a preliminary hypodermoclysis before operation might prove of value, ℥iv, ℥vi, or ℥viii, and repeated again before the anesthetic is removed. In the *New York Medical Journal*, De-

cember 2, 1899, in the conclusion of an article entitled, "Further Experimental Researches on the Effect of Different Anesthetics on the Kidneys," I cite a patient of Dr. William H. Thomson, upon whom I operated for tuberculous disease of the elbow-joint. Nitrous oxide and oxygen were selected as the anesthetic, as the patient had a small amount of albumin in the urine and also granular casts. Dr. Bennet administered the anesthetic for thirty-five minutes. A hypodermoclysis of ℥vi of normal saline solution was given in the ilio-lumbar region just before the removal of the anesthetic. Though albumin was present in the urine the day before and the morning of the operation, and even in the urine voided just before anesthesia was begun, and also a considerable number of casts were found, the albumin was absent after operation; the casts diminished in number, and the urine increased 23 ounces twenty-four hours after operation, over the amount voided twenty-four hours previously. The patient had at no time any difficulty whatever. This case is certainly suggestive at least, and as such is reported. If shock occurs during operation, or if it is feared from any cause, hypodermoclysis should be employed as an adjunct to other methods. As a post-operative procedure, in renal complications, sepsis, or shock, it is unquestionably a valuable adjunct.

Other indications are the same as for infusion.

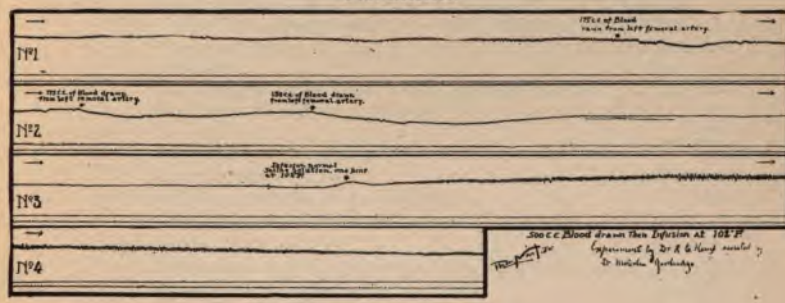
Note.—Dr. Tilden Brown suggests that in post-operative intestinal paresis one pole of the battery be attached to the central metal tube of the new model irrigator and the other pole be placed just below the ensiform cartilage of the sternum. The entering saline solution will thus be charged with electricity.

Infusion.

Needling a superficial vein is a rapid and easy method, especially in uremia or in septic conditions. Infusion is at times objected to by the family as an operation, while the simple puncture would seem no more than a hypodermic injection. In shock and in similar conditions we can instantaneously secure benefit, meanwhile an infusion being performed. Some valuable minutes are thus saved, which may markedly influence the result to the patient Even. a few ounces of normal saline solution at 120° F. have a marked influence on heart stimulation.

We herein insert a plate demonstrating that infusion at 102° F., which many advocate, has but

FIG. LXXXI.



Infusion at 102° F.

slight effect as a cardiac stimulant. This plate was obtained too late to insert under the illustrations in Infusion.

Conclusion.—We have endeavored in our manual to demonstrate the methods which would seem to be of most value to the general practitioner, and if we have been able to secure this result, we feel that we are amply repaid and have fulfilled our task.

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